SOCIETY OF BROADCAST ENGINEERS

Certification Handbook for Radio Operators

2nd edition

SBE.

By Ron Bartlebaugh, CBNT
Director of Broadcast Engineering
The WKSU Stations

Preface

The purpose of this book is to inform and prepare individuals to handle the responsibilities as an operator of an AM or FM radio broadcast station. This guide will not only inform and educate but it will also prepare the reader for the radio operator certification examination that is available through the Society of Broadcast Engineers (SBE). The SBE is a national non-profit organization that has been in existence since 1964. Its mission is to inform and educate those involved in the broadcast engineering industry and its associated industries. The SBE's membership enrollment is more than 5,400 individuals from AM, FM and TV broadcast stations, recording studios, schools, and other affiliated organizations. There are currently 107 local SBE chapters in 46 states and territories. Most chapters conduct monthly meetings and frequently offer tours of broadcast or related facilities in their area as well as occasional specialized educational technical seminars. Information about a local chapter in your area may be found on the SBE website at http://www.sbe.org.

The SBE, with national headquarters in Indianapolis, is managed by a full-time staff and a board of directors who represent many years of broadcast experience. In addition, there are several committees within the SBE. One such committee is the Certification Committee. The SBE offers industry certification on several levels through a series of formalized tests designed to gauge a person's knowledge of broadcast engineering, operations standards and methods as well as familiarity with the Federal Communications Commission's (FCC) rules and regulations that are applicable to the operation of AM, FM, and TV broadcast stations. Certifications are available at several different levels and are divided between television and radio. Additional information about the various certification levels and programs is available on the SBE website. This book addresses the radio operator certification level.

The book discusses the requirements of a radio station operator from the perspective of the station owner as well as the station's engineering staff. It will also discuss an operator's requirements as they relate to the FCC rules and regulations. While this publication is not intended to be technical in nature, it will provide a good overview of a radio station's equipment in such a manner that the reader will become sufficiently familiar with the various types of equipment and methods utilized at a typical radio station. The reader will also gain knowledge of the many technical terms used in broadcasting. This book provides an overview of a typical radio station studio and the equipment found therein. Audio mixing and routing devices, microphones, computerized recording and playback systems, telephone-interface equipment, patch panels, electronic routers, equalizers, headphones, transmitter remote control and monitoring systems, audio processors, satellite systems, and program-audio delay equipment are but a few of the many topics that are covered.

The FCC once required that all announcers/station operators possess a Third-Class radiotelephone operator license with a broadcast endorsement. In 1995 the FCC eliminated all operator-licensing requirements. Having a Third-Class FCC license with a broadcast endorsement was an industry standard for determining the qualifications of a person to work in the industry. The SBE radio operator certification test covers the same types of items as the FCC Third Class license test. The broadcast industry now utilizes the SBE certification program as its standard, in place of the former FCC licensing programming for determining a person's broadcast knowledge, skills, and abilities. Upon the completion of studying this book, the student should be well prepared to take the SBE radio operator certification test. The successful completion of the test will provide proof to a prospective employer of the student's knowledge necessary to operate a radio station.

About the Author

Ron Bartlebaugh, CBNT, is the Director of Broadcast Engineering at public-radio station WKSU-FM at Kent State University in Kent, Ohio. WKSU owns and operates a network of six FM stations in northeast Ohio. For 30 years he also owned and operated Audio and Broadcast Specialists, an electroacoustic design and engineering company that provided technical services to the broadcast and prosound industries. He is certified by the Society of Broadcast Engineers as a Certified Broadcast Networking Technologist. Bartlebaugh has regularly written articles for *Radio* magazine since 1997. He has been employed in the broadcast industry for more than 30 years and is the former chief engineer of WCRF-FM, Cleveland. He holds a General Class amateur radio license and is an active amateur radio operator with callsign W8JPG. He is a member of the Society of Broadcast Engineers Chapter 70, The Acoustical Society of America and The Audio Engineering Society.

About the Society of Broadcast Engineers

The Society of Broadcast Engineers, Inc. (SBE) is a non-profit organization serving the interests of broadcast engineers. It is the only national organization devoted to all levels of broadcast engineering.

Membership is international in scope and consists of studio and transmitter operators, technicians, supervisors, chief engineers, engineering managers, directors of engineering, consultants, field service engineers and sales engineers. Engineers from recording studios, schools, CCTV and CATV systems, production houses and related technologies and industries are members also.

The SBE provides education and a certification program, maintains a training library and provides educational material for the broadcast engineering community. There are many other services provided by the Society, including employment services with JobsOnline and a Resume Service, computer and amateur radio communications, life and health insurance and more. The SBE has created the Ennes Educational Foundation Trust which is devoted to the advancement of broadcast engineering through educational seminars and the awarding of scholarships. The SBE also represents the technical interests of broadcast engineers and their stations before the FCC and other governmental bodies. The SBE publishes a bimonthly newsletter, *The Signal,* for its more than 5,400 members in more than 100 chapters.

If you would like information about becoming a member of the SBE, or if you would like to inquire about SBE services, please contact:

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Please Read the Following Disclaimer:

The SBE *Certification Handbook for Radio Operators* is supplied solely as a teaching aid for individuals preparing for SBE certification. It is not intended to be an authoritative source of information on current rules and regulations. Federal Communications Commission rules and broadcast technology are constantly changing. For these reasons, the reader is cautioned to refer to the current Code of Federal Regulations for up-to-date and detailed information.

Every effort has been made to ensure the accuracy of the information provided herein. The author and the Society of Broadcast Engineers Inc., make no warranty of any kind and will not be held liable for any errors or omissions.

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1

The Role of the Federal Communications Commission

1.1 Who is the FCC?

The Federal Communications Commission, (FCC), is a federal government agency that oversees and regulates the non-governmental wireless and wired telecommunications industries. The Commission itself is made up of five members who are each appointed to a five-year term by the President of the United States and who must then be confirmed by the Senate. The President appoints one of the five commissioners to serve as chairman. There are many departments that operate with the oversight and guidance of the FCC commissioners. One such department is the Media Bureau, which regulates the broadcast industry. The FCC rules and regulations pertaining to the broadcast industry are created by this department. Enforcement of these rules is the responsibility of another department within the FCC called the Enforcement Bureau. FCC rules are found in the Code of Federal Regulations Title 47, Parts 11, 17, 73, and 74. Part 11 covers the rules regarding the Emergency Alert System (EAS). Part 17 pertains to broadcast tower painting and lighting. Part 73 of the Rules deals with AM, FM, and TV stations as well as short-wave radio broadcast stations. Part 74 deals with broadcast auxiliary services such as studio-to-transmitter (STL) links, remote pick up (RPU) systems and other associated systems. Each station owner should have a current copy of the Rules available at the station. It is recommended that each station operator become familiar with the FCC rules and regulations that pertain to his or her responsibility as a station operator. Copies of The Code of Federal Regulations title 47 parts 11, 17, 73, and 74 are available from the Government Printing Office or its website at http://www.access.gpo.gov and on the FCC website at http://wireless.fcc.gov/rules.html. Specific rules that a station operator needs to know will be referred to from time-to-time in this book. The FCC can, at its discretion, assess monetary fines upon a station when any of the FCC's rules and regulations are violated.

The FCC expects the station operator to adhere to all applicable FCC rules and regulations pertaining to the operation of the station at which the operator works. Knowledge and proper application of the FCC rules are important. Additional information about the FCC can be found on the Internet at http://www.fcc.gov.

1.2 FCC-Assigned Use of Frequencies

AM and FM broadcast stations transmit on an FCC-assigned frequency. There are currently few unused radio station frequencies within the United States. The lower end of the FM radio frequency band from 87.9MHz (megahertz) to 91.9MHz is called the reserved band and is available only to non-commercial educational radio stations. The FM frequencies between 92.1MHz and 107.9MHz are known as the commercial (non-reserved) FM frequency band. Commercial frequencies are in the greatest demand, although the demand for the reserved band frequencies has escalated in recent years due to the expansion of public and religious radio broadcasting. Other than brief underwriting announcements, the FCC prohibits the airing of commercials on the reserved band. Typical owners of reserved band, non-commercial FM stations are educational institutions, religious organizations, and community licensees.

AM broadcast station frequencies are contained within the band from 540kHz (kilohertz) to 1700kHz. This band of frequencies is not divided between reserved and commercial (non-reserved) frequencies as is the FM band. AM and FM stations are divided into different classes as shown in Figure 1-1.

AM Stations

Class	Channel Type	Time of operation	Areas of coverage	Power range
A	Clear channel	Unlimited	Extended areas	10kW to 50kW
B	Local and regional channels	Unlimited	Primary areas	250W to 50kW
C	Local channel	Unlimited	Primary areas	250W to 1kW
D	Local or regional channels	Limited nighttime	Primary areas	250W to 50kW

FM Stations

Class	Power	Effective Height (m)
A	6kW	100
B1	25kW	100
B	50kW	150
C3	25kW	100
C2	50kW	150
C1	100kW	299
C0	100kW	450
C	100kW	600

Figure 1-1
Classes of AM and FM stations.

FM stations are assigned channel numbers by the FCC. These numbers begin with channel 201 for the lowest FM frequency of 88.1 megahertz and continue upwards frequency by frequency to channel number 300 for the highest FM frequency of 107.9 megahertz. Channel numbers are indicated on FCC licenses and are often used by consulting engineers when determining available frequencies for operation. There are a total of 100 FM frequencies or channels. Figure 1-2 shows examples of FM channel assignments by frequency.

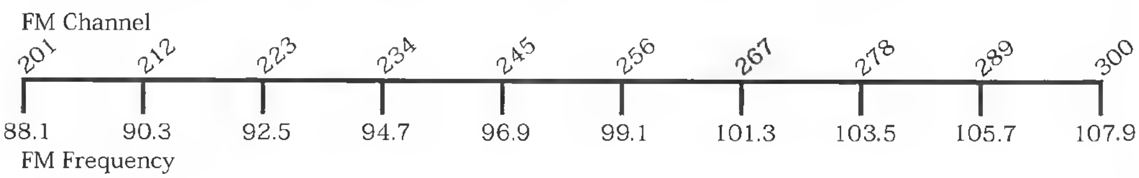


Figure 1-2 Examples of channel assignments by FM frequency.

1.3 Radio Station Licensing by the FCC

Every broadcast station is required to have an authorization issued by the FCC. The most common type of authorization is a station license, but there are also construction permits (CP), special temporary authorizations (STA) and experimental authorizations. A station license gives authority to its holder to operate a specific type of radio station within a given set of technical and location parameters. The FCC limits the number and type of AM and FM stations in an area via a national frequency allocation plan that was derived many years ago. The FCC's frequency allocation plan is intended to assure that stations will not cause interference to or receive interference from another broadcast station within their assigned coverage areas. Broadcast stations have become expensive to obtain partially due to the fact that the number of possible frequencies for use in an area is limited by the FCC and almost all available frequencies are in use.

There are three primary types or classes of licenses for FM stations as shown in Figure 1-1. All FM radio stations are permitted to broadcast 24 hours each day while some AM stations are only permitted to broadcast from sunrise to sunset. Those AM stations are known as daytime-only stations, also referred to as daytimers. Daytime stations are limited to operating from sunrise to sunset so as to not cause interference to other AM radio stations, because AM signals typically travel farther at night than during the day due to atmospheric conditions that are affected by the Sun. In some cases, an AM daytime station may have pre-sunrise authority (PSRA) and postsunset authority (PSSA) whereby the station would be authorized to operate at incrementally reduced power for a short time period before sunrise and past sunset in order to provide some local signal coverage while minimizing potential interference to other stations. Also, many AM and a few FM stations may utilize a directional antenna (DA) system in order to concentrate their signal in certain directions. This is often required for one station not to interfere with another.

The use of directional antennas also permits more stations to be on the air since the potential for interference from one station to another can be tightly controlled by the antenna system. Figure 1-3a shows the signal radiation pattern of a non-directional (omnidirectional) radio station and Figure 1-3b shows the radiation pattern for a directional station. In most cases, no two directional signal radiation patterns are the same as each one will have slightly different requirements based on its location and frequency of operation.

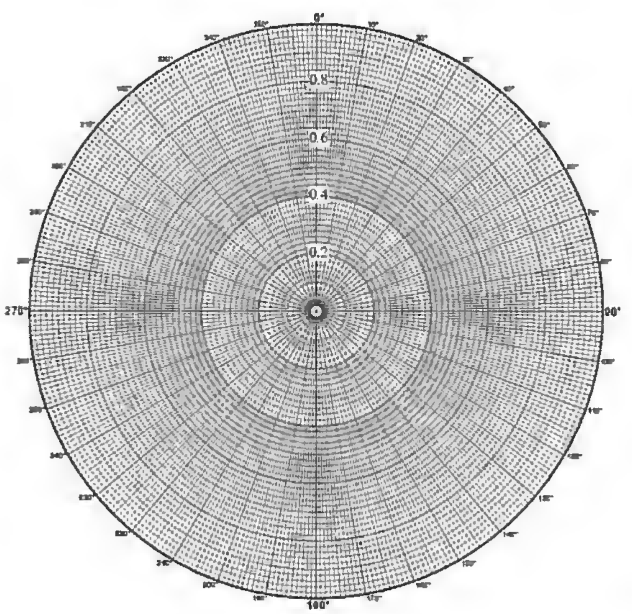


Figure 1-3a A non-directional signal pattern.
Courtesy of Hammett & Edison, Inc.

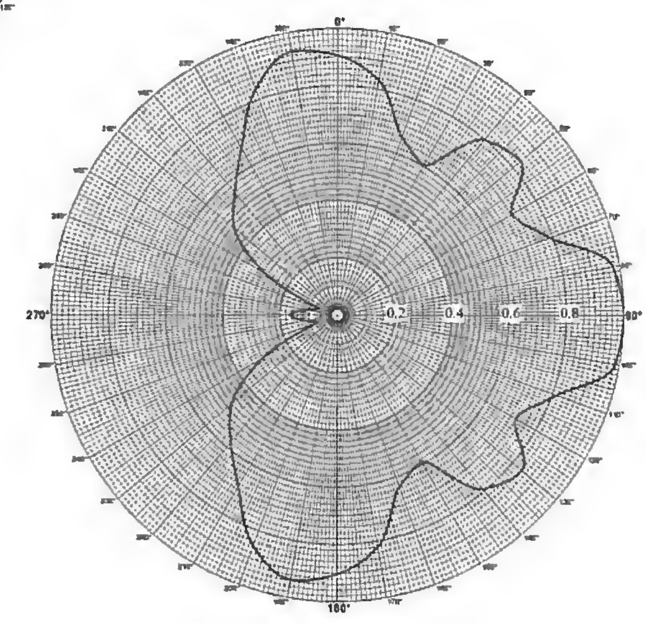


Figure 1-3b A directional signal pattern.
Courtesy of Hammett & Edison, Inc.

1.4 Obtaining an FCC Broadcast Station License

The license of an existing radio station may be purchased when the owner of the license and the prospective buyer reach an agreement of sale. The cost to purchase an existing station will range from tens of thousands of dollars upwards to tens of millions of dollars depending upon the station's class and the size of the market that it serves. FCC approval is required on all station transactions.

In other cases, when an available frequency can be identified in an area, a person, company, or group can apply to the FCC for a construction permit to build a new station on that frequency. This is a complicated, expensive and long-term process. Often there may be multiple applicants for the same frequency at the same location, which then extends the process even further; perhaps for many years. The station can be built when the FCC awards a construction permit to the successful applicant.

After the station has been constructed and tested, the applicant then applies to the FCC for a station license, which when issued, is authority from the FCC to operate the station according to the technical parameters indicated on the construction permit. A broadcast station license is normally good for a term of eight years, at which time the license needs to be renewed by following a stringent FCC-mandated process. FCC rule 73.1230 requires the station's license be posted at the control point of the station in a conspicuous location where it can be easily seen or quickly located for reference. The control point is usually the station's on-air studio or other location as designated by the station's management. It is a violation of the FCC rules and regulations to operate an unlicensed radio station, to operate a licensed station in excess of its specified operating parameters, or to operate it from a non-licensed location.

A substantial financial investment is required by the owner of a reserved-band non-commercial FM station, a commercial FM station, or an AM radio station to obtain and maintain its station license. Radio broadcasting is an expensive business and, like most other businesses, cash flow is important. The radio operator is the final line of communication between the radio station and the listener. The station owner depends heavily on the abilities of the radio operator to deliver the station's programming to the public in the most professional manner possible. One must take the position of radio operator seriously and perform his or her duties accordingly.

2

The Requirements and Responsibilities of a Radio Station Operator

2.1 The Definition of a Radio Station Operator

A radio station operator can be defined as the person who is responsible for the operation of the station's equipment in the manner necessary for the delivery of program material to the listener in accordance with all applicable FCC rules and regulations, and the policies set forth by the station owner. The station's operator may be the announcer (disk jockey) or it may be a person who is on duty and responsible for operating the station's broadcast equipment while airing a program that originates from the studio or from a source outside the studio such as a remote broadcast or a network feed. The operator must be accountable to both the station's owner as well as to the FCC. A good operator will thoroughly understand the expectations of both and act in a reasonable and responsible manner to uphold his or her responsibility as the station operator.

Ultimate responsibility for the station's operation in accordance with all FCC rules and regulation falls upon the station's owner. However, if the station operator conducts himself or herself contrary to those rules and regulations, both the station owner and the station operator could be found at fault by the FCC.

2.2 The Accountability of the Station Operator

While the FCC no longer licenses station operators, it does expect each operator to adhere to all applicable rules and regulations pertaining to the operation of the station at which the operator works. If an operator fails to do so, he or she could not only place himself or herself at risk of being fined by the FCC, but also place the station owner in the same situation. Fines can range into the thousands of dollars so knowledge of the Rules and their proper application are most important. If a station was to be fined, it not only will cost the station a substantial amount of money, but that station's reputation may also be affected in a negative manner.

The station's owner expects the station operator to act in the manner as dictated by the station's policies and procedures and as required for the proper delivery of the station's program material to the listening public. Sometimes the station operator will be accountable directly to the station's program director who is responsible for providing the necessary guidance to the station operator.

In addition to being accountable to the FCC and the station's owner and the program director, the station operator should always be accountable to the station's chief operator. The term chief operator comes from FCC rule 73.1870, which states that the chief operator shall be responsible for making sure that the station operates according to all applicable FCC rules and regulations as well as according to the terms of its station license. The chief operator of a station will often create and supervise station policies of program delivery and transmitter operation that will assure compliance with the FCC rules and regulations. In most cases, the station's chief operator is also the station's chief engineer. The chief engineer is typically the person responsible for the installation, operation, and maintenance of the station's broadcast equipment and may also maintain the station's FCC licenses. The station's owner may appoint someone other than the chief engineer as the station's chief operator. At smaller market stations, the station's owner or general manager may also be the chief operator and – in limited situations – may also be the station's chief engineer. FCC rule 73.1870 requires that a written designation of who the station's chief operator is be posted with the station's FCC license. Figure 2-1 shows a typical chief operator designation.

RADIO STATION WXYZ
123 Anywhere Street
Hometown, U.S.A. 55555

January 15, 2015,

To Whom It May Concern:

Be it known that John Doe is the appointed Chief Operator of Radio Station WXYZ. In his absence Joe Smith is to act as the Chief Operator.

Appointed by:

William Smith
General Manager, WXYZ

Figure 2-1 A chief operator posting.

While the chief engineer/chief operator is ultimately responsible for the station's adherence to the FCC rules and regulations, it is the station's operator who is responsible for the proper program delivery in a manner that complies with all applicable FCC rules and regulations. The station operator should never make assumptions about a station policy or FCC rule. When in doubt, always ask for clarification first to avoid a possible FCC fine later.

3

Radio Station Management Structure and Etiquette

3.1 Station Management

A radio station typically has a general manager. The station owner and the general manager may be one and the same depending upon the size of the station and the size of its market. Sometimes the general manager may be called the station manager. The role of the general manager is to oversee the day-to-day operation of the station as well as to establish goals for the station. In short, the general manager is the boss.

Directly under the general manager in the chain of command of station management are the program director, the sales manager, the business manager and the chief engineer. At most stations these four positions are of equal level on the management scale meaning that they all have similar responsibilities and levels of authority, but for different facets of the station operation.

The program director is responsible for creating, scheduling and airing the station's programming. He or she typically monitors audience response to the station via Nielson Audio (formerly called Arbitron) or other similar ratings services and makes adjustments to the programming presented over the station based on audience ratings, the program director's general knowledge of radio programming and the overall goals of the station's owner. The program director is usually responsible for managing and scheduling the station's operators. Decisions regarding who to hire as a station operator are typically made by the program director and the general manager. One or both of these individuals may supervise the station operator.

The sales manager is responsible for generating sales revenue for the station. He or she typically has a staff of sales representatives, also known as account executives who are managed and utilized as a team to sell commercials, remote broadcasts, and other revenue-generating products for the station. The sales team depends heavily on the station operator to properly air the commercials and other programs in a timely and professional manner as billing for those products is not issued to the customer until the commercial or program has successfully aired.

The business manager is the person who generally oversees the business operation of the station from a financial and personnel standpoint. It is the business manager who will usually control the station's expenditures including the authorization of equipment purchases when needed. This position will often establish policies and procedures for station personnel and may be responsible for the station's payroll, accounts payable, and accounts receivable. The business manager will keep the station's owner well informed as to the financial status of the radio station operation at any given moment.

The station chief engineer has the responsibility for installing, maintaining, and repairing the station's technical broadcast equipment. That equipment includes everything from the microphone to the transmitter and antenna. The chief engineer may frequently instruct the station operator regarding proper operating procedures to assure the station remains in compliance with all applicable FCC rules and regulations.

It is important for the station operator to become adequately familiar with the station's staff. The operator should learn the chain of command and thus know who to go to when a question needs to be answered or a need otherwise fulfilled that applies to the proper operation of the radio station. Respect of the station's staff is of the utmost importance. An attitude of professionalism and a desire to do the best job possible will go a long way towards making a lasting impression on the station's management and towards the overall success of the station.

3.2 Food, Beverage, and Smoking in the Studios

It is important to become aware of the station's policies concerning the consumption of food and beverage in the studios or offices as well as the station's smoking policy. Many stations do not allow food or beverage in a studio because an accidental spill can damage delicate electronic equipment. Stations may have a no smoking policy or may permit smoking only in designated areas. Cigarette smoke can cause damage to electronic equipment. Learn and respect the station's policies.

3.3 Answering the Telephone

Answering the station's telephones after normal business hours may be the responsibility of the station's radio operator. What you say over the air represents who and what the station is. Second to that is your conduct over the phone. Often people will call with a request for specific information or to leave a message for a staff member. It is important to properly and professionally represent the radio station over the phone and handle each call as if it were the most important phone call ever received.

Many stations have a voice mail system. Learn how it works so that you can promptly and professionally transfer calls to the voice mail system when required. A single call could represent substantial sales revenue to the station.

3.4 Emergency Plans

Every station should have an emergency plan. Emergencies can be anything from a person requiring medical assistance to a fire in the facility to a tornado moving through the area. In smaller markets especially, residents of the area heavily depend on their local radio station for emergency related information. Learn the station's procedures for emergencies that may occur at the station and also for emergencies within its broadcast area. Know where the emergency phone numbers are at your station and be prepared to quickly use them if necessary. Not only will you need the emergency phone numbers for the local law enforcement and fire departments but also for contacting the station's staff including, but not limited to, the station's program director and chief engineer. Your knowledge and proper conduct during an emergency situation may save lives.

3.5 The News Staff

Most radio stations have a news department of varying size. Large-market stations will typically have several people on their news staff as reporters and/or producers. Small-market stations may have only one or two people on news staff. If you are staffing a station after normal business hours, and you are the only person at the station, it will be important for you as the station's operator to know how to contact the news staff in the event a breaking news story occurs. In some cases, especially at smaller market stations, the station operator may also be responsible for producing and airing the newscasts as well as disseminating emergency announcements. That being the case, be sure to always learn what the station's policies are regarding the airing of those types of programs and announcements.

3.6 The Non-Commercial Educational Station Environment

We have discussed staffing and operations criteria applicable to a commercial station. Many non-commercial stations have a limited staff. Typically the sales manager is replaced by an underwriting development associate. While non-commercial stations are not permitted to air commercials they are permitted to air underwriting announcements. Such announcements are made when a business provides financial support to the station in return for the station airing underwriting announcement acknowledgments. The development associate is, in reality, a sales person who solicits underwriting business. The non-commercial station most likely will have a general manager, but that person may also be the program director. The station's chief engineer may be a part-time contract employee who only works a few hours per week and is otherwise available (on-call) for emergency situations of a technical nature. A non-commercial station may or may not have a news department. Even with all of this in mind, the station operator is still expected to conduct himself or herself in the same professional manner as if at a large-market, fully staffed station. Many of the same issues and policies that were discussed for commercial stations also apply to non-commercial stations. Whether working at a commercial or non-commercial station, always learn the expectations of the station management and its staff. Living up to those expectations and otherwise doing your job in a professional manner will go a long way towards position advancement or securing that next big job.

4

The Technical Layout and Equipment of a Typical Radio Station

4.1 Basic Description

Every radio station has a microphone and a transmitter with an antenna and a lot of other equipment, but how does it all work? This chapter will explain the technical layout of a radio station. Every station operator should have a basic understanding of how a radio station functions.

A radio station studio is a room with equipment that facilitates the airing or recording of programs. A typical radio station studio is shown in Figure 4-1.

Figure 4-1 A typical radio station studio. Photo by Chriss Scherer, CPBE, CBNT.

Some radio stations may have multiple studios or rooms. One room may be designated as the on-air studio. This is where the programming is generated or otherwise controlled as it is put on the air. A production studio is a room where radio programs or commercials are recorded. Some production studios may also serve as back- up or standby on-air studios. A news studio is where newscasts typically originate. The master control room may also be the on-air studio or it may be a central control or technical point.

The block diagram shown in Figure 4-2 illustrates the various pieces of equipment involved in creating a broadcast signal beginning with the microphone and ending with the station's transmitting antenna. The path begins at the left and ends at the right. Descriptions of the various components shown in Figure 4-2 are described in the following sections.

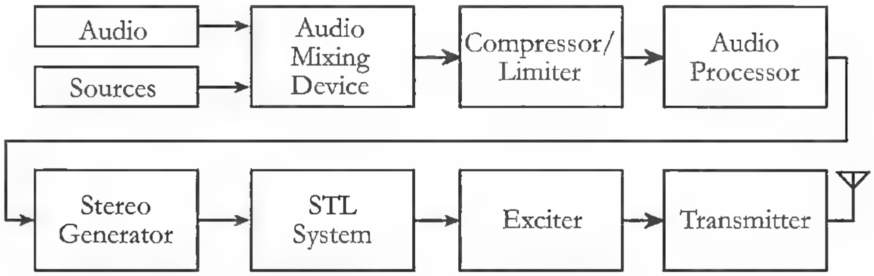


Figure 4-2 Block diagram of a typical radio station air chain.

4.2 Microphones

The typically first and most used device in the broadcast chain is the microphone. The purpose of a microphone is to reproduce the sounds (audio) it detects in the most accurate manner possible according to the design and quality of the microphone. There are many different types of microphones. The two most popular are the cardioid or unidirectional and the omni-directional microphone. As the name suggests, the omni-directional microphone picks up sound from all directions. The cardioid microphone picks up sound mostly from the front of the microphone element and tends to reject most of the sound received from the back of the microphone. This type of microphone also possesses proximity effect meaning that the closer a person speaks into the microphone the more there will be an increase in low-frequency (bass) sound.

Many announcers prefer a cardioid microphone because it makes their voices sound deeper when taking advantage of the proximity effect. Figures 4-3 and 4-4 illustrate the difference in voice pickup patterns between a cardioid and an omni-directional microphone.

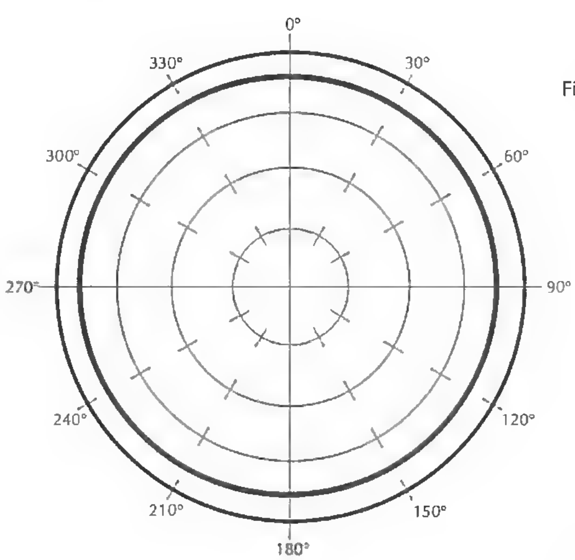


Figure 4-3 Omni-directional microphone voice pickup pattern.

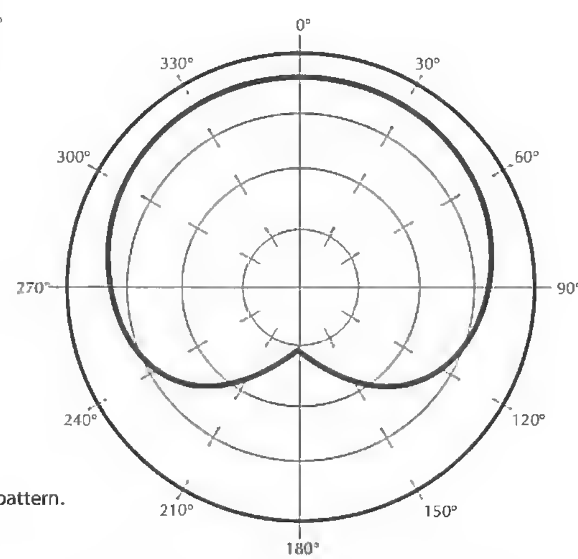


Figure 4-4 Cardioid or unidirectional microphone voice pickup pattern.

A person should speak directly into a microphone to achieve the best voice reproduction. Speaking away from or at a sharp angle from the microphone is referred to as being off-axis. An off-axis voice will not be properly reproduced in that it will sound hollow and otherwise not complete in sound quality.

All microphones have a metal mesh opening at one end. In addition, some unidirectional microphones will also have openings around the microphone below the metal mesh top screen. Figure 4-5 shows a typical omni-directional microphone and Figure 4-6 shows a typical unidirectional microphone.

Figure 4-5 An omni-directional microphone. Photo by Chriss Scherer, CPBE, CBNT

Figure 4-6 A unidirectional or cardioid microphone. Courtesy of AKG Acoustics.

Most microphone elements can be described as dynamic or condenser. A dynamic microphone is usually capable of reproducing louder sounds whereas a condenser microphone typically has better sound reproduction qualities throughout its frequency range. A condenser microphone requires a voltage to be applied to it element for it to properly operate. When the voltage is applied through the microphone cable from the device to which the microphone is attached, the voltage is known as phantom power. Condenser microphones are prone to damage from moisture. A dynamic microphone would be a good choice of use by an announcer who desires to speak very close and rather loudly into the microphone. A condenser microphone is a better choice if a wide-range of sound pickup is desired. However, condenser microphones should not be used close to the mouth or with louder speaking announcers as the sound may distort.

Foam windscreens are frequently used over microphones to minimize the popping effect that a microphone may have when the user produces too much breath into the microphone. Windscreens are sometimes known as pop filters. Windscreens should be used outdoors when doing a remote broadcast or other types of production to eliminate the rumbling noise that a microphone will reproduce when wind blows into its element. A blast filter is a round device with a thin cloth filter stretched tightly across it. A unit of this type, when placed in front of the microphone element, can be very effective at reducing noise caused by excess air being forced into the microphone.

All professional microphones are low-impedance units and have an industry-standard three-pin connector defined as an XLR connector. The term impedance refers to the electrical resistance of the microphone. All professional microphone cables internally have two wires (conductors) and a shield surrounding the two wires. These are called balanced microphone cables and are so named for the method in which the audio energy from the microphone is transmitted through the cable. Only low-impedance microphones that employ a balanced microphone cable with XLR connectors should be utilized in professional applications. An XLR connector has three pins; two for the connection of the wires carrying the audio energy and a third for the connection of the audio cable ground or shield wire. Figure 4-7 shows the male and female XLR connectors.

Figure 4-7 Male (left) and female XLR connectors. Courtesy of Neutrik.

4.3 Speakers and Headphones

Every radio station will have the ability to monitor itself within the studio via speakers and headphones. ***A note of caution needs to be expressed: listening to sound at high volume on speakers or headphones can cause hearing damage.*** Also, having the speaker volume turned up too loud in one studio may cause sound leakage through the walls into the next studio, which would then interfere with the recording process in the adjacent studio. It is important the station operator always follows proper monitoring procedures as set forth by station policy.

4.4 The Audio Mixing Device

The term audio mixer or audio mixing console has been in standard use at radio stations nearly since the invention of broadcasting. Other slang terms for that type of device are console or board. For descriptive purposes, we will refer to an audio mixer using the most-current term of audio mixing device. An audio mixing console will typically have all studio microphones and other audio sources connected to its input channels. The person operating the console, often defined as the station operator or board operator, will create a blended mix of the audio sources to be placed on air using the console's VU meters as an audio level reference. That mix of audio sources is then routed internally in the console to the console's output channel where it is connected to the radio station air chain as shown in Figure 4-2.

In recent years the use of digital technology has become increasingly popular in radio station studios. That has led to the creation of a new type of audio mixing device known as a work surface, control surface or digital console. These types of systems are all computer-based with the audio sources and output(s) being connected to the system's computer – also known as an engine. The work surface takes on the appearance and operation of an audio mixing console as mentioned in the previous paragraph but functionally acts more like a keyboard connected to a computer. These types of units are typically more versatile, use flat-screen video monitors for displaying reference materials such as audio levels, and otherwise operate much like an on-screen computer-based audio mixer would.

Each microphone and any other audio source used at a radio station for programming will be connected to an audio mixing device. There are many different types of audio systems. One of the most popular is a computer-based system for the playback of pre-recorded announcements, commercials, and music. A few of the many possible others are a telephone system used for placing callers on-the-air, remote pick-up units for receiving audio from a

local live broadcast, or an audio source delivered via satellite from an audio network provider. In some cases there may be multiple units of the same type therefore many audio sources may be connected to the audio mixing device. Figure 4-8a shows an example of an audio mixing console, and Figure 4-8b shows a digital work surface.

Figure 4-8a An audio mixing console.
Courtesy of Wheatstone Corporation.

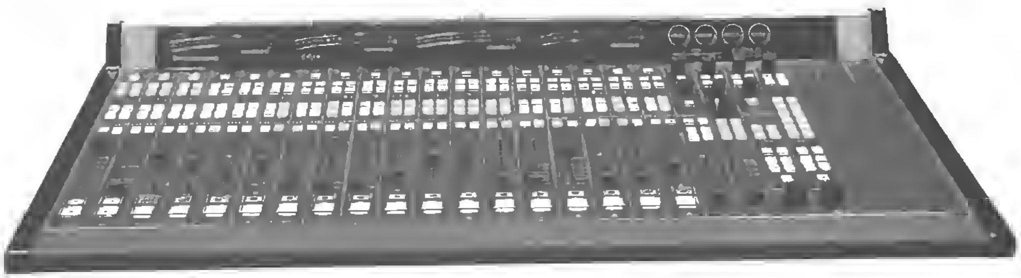


Figure 4-8b
A digital audio work surface. Courtesy of Wheatstone Corporation.

Every audio mixing device will have multiple inputs, known as channels or input channels. The input channel arrangements on basic (non-digital) audio mixing consoles can usually accommodate one or two audio sources per channel. Most audio mixing consoles manufactured for broadcast use will have an "A" input and a "B" input on each of its input channels. The "A" position of the channel selector switch connects a specific audio source to that input channel while selecting the "B" input would route a different audio source to be connected to that particular input channel.

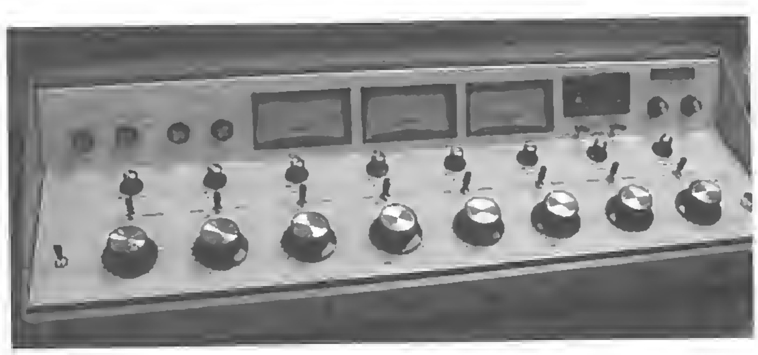


Figure 4-8c
An audio mixing console with rotary pots. Courtesy of Autogram

Digitally based audio mixing devices typically have the ability to direct multiple audio sources into the audio mixing console-appearing work surface on channel-by-channel basis and in whatever sequential layout desired by the operator. The audio sources appearing at the input channels can be quickly changed, whereas the audio sources for the audio mixing consoles described in the previous paragraph are not so easily changed beyond the use of the console's input selector switch or other basic methods that will be described in later text.

The volume of sound for a particular input channel is known as the audio level. The term "level" is often used when referring to the audio level or volume of a sound source. The level for an input channel is controlled by a device called a potentiometer, which is the electro-mechanical device that is used in the input circuit to vary the amount of audio. Potentiometers are commonly called pots. There are two types of pots used in audio mixing devices. The slider pot gets its name because its control slides up and down on the console. The console in Figure 4-8a and 4-8b have slider pots. The older style (rarely used) rotary pot has a round knob that is turned clockwise and counterclockwise, as shown in Figure 4-8c.

All professional broadcast audio mixing devices have some type of audio level reference metering that is used as a visual reference to determine the audio level being processed by the device. The meters are known as VU meters and are calibrated in volume units and/or decibels (dB) when used for analog audio referencing and as peak reading dBFS (decibels full scale) when referring to digital audio. Both types of meters measure the relative difference in signals. Figures 4-9a and 4-9b show examples of each type of meter.

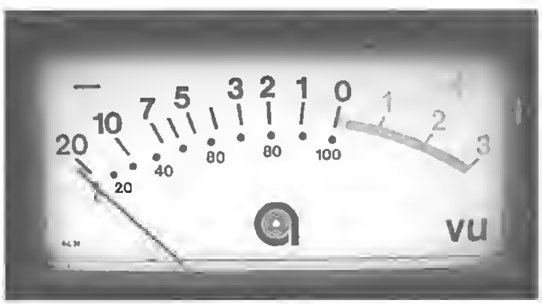


Figure 4-9a An analog display VU meter. Photo by Benton H. Weiss, CPBE.

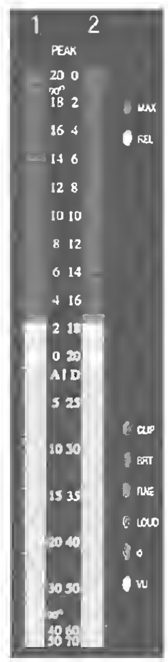


Figure 4-9b A digital audio LED bar graph display VU meter. Courtesy of Logitek.

The LED bar graph displays are typically more accurate because of their faster response to changes in audio levels. The time that it takes for the needle pointer in an analog meter to respond to changes in audio level, known as the meter's ballistics, reduces that meter's ability to quickly respond to peak changes in audio levels. Both types of meters, however, are widely used throughout the broadcast industry in various applications. The analog VU meter is calibrated in percentage from 0 to 100 and in decibels ranging from minus 20dB to plus 3dB. The term minus means that the audio is so many decibels below a reference level of zero dB, whereas the term plus means that the audio level is so many decibels above the zero reference level.

An LED bar graph dBFS digital audio meter displays the sample values of a digital audio signal. The scale, known as digital full scale, has 0 dBFS representing the highest permissible and possible sample value. Samples displayed above 0dBFS will distort the digital waveform causing the audio to be imperceptible and otherwise may be permanently lost from the digital file.

When working with analog audio, the level of the audio sources should be adjusted by using the audio mixing device pots so the VU meter reads an average level between -6 and 0 VU or between 50 and 100%. Occasional audio peaks that read plus 1 or 2 on the meter are normally acceptable. An audio level that barely moves the VU meter may be difficult to hear on the air, and one that forces the VU meter to its maximum reading (slamming the meter) will mostly likely distort the audio. Distortion is defined as a diminished clarity in sound reproduction and is therefore undesirable. An analog VU meter scale has a red zone above its 0 VU level mark indicating that audio of that level is excessive and can potentially distort. A bar-graph VU meter will change to a different color when the audio reaches the level above 0 VU.

When operating in a digital audio realm, the dBFS meter equivalent to a 0 dB full scale analog VU meter reading is typically either -12dBFS or between -18 to -20dBFS. The choice level of operation will more often than not be instructed to the station operator by the station's chief engineer or others in charge of audio at the station. The -12dBFS digital audio level is most often used in the broadcast world whereas the -18 to -20dBFS level would be more likely found in use at production facilities where a greater dynamic range of audio is desired.

Audio dynamic range is defined as the variation between the quietest or lowest audio level and the loudest or highest audio level in an audio recording or live broadcast. Classical music is a good example of material that has a wide dynamic range. This music contains sound levels that vary from very soft passages to loud crescendos. Most rock music is said to have a narrow dynamic range because it is often recorded and processed at continuous high levels. It is the dynamic range of audio that causes a VU meter to fluctuate in its readings. Program sources that have a narrow dynamic range can, for the most part, have their levels set on the VU meter and all will be fine. Alternatively, a program with a wide dynamic range may require that the operator pay careful attention to the VU meter readings and adjust the pot upward during quiet passages and downward during louder passages. That procedure is called gain riding, whereby adjusting the pot upward or downward, you are – in a sense – riding the pot and adjusting the volume or gain of the input channel's audio amplifier to produce the correct VU meter reading. Many radio stations have a device called a compressor/limiter that is capable of automatically riding gain. Those devices will be discussed later in this book. Even if a station has an automatic gain riding device it is still a good practice to pay close attention to the VU meter level and do what is necessary to keep the audio level within the proper range at all times.

When mixing multiple audio sources into many audio mixing device input channels simultaneously, one must blend all of the audio sources so they sound correct and well balanced. This is called audio mixing, or mixing. Some audio mixing devices have a VU meter for each input channel making it easier to create a mix of the proper audio levels. Most common broadcast consoles, however, only have VU meters that show the console's output. At most radio stations the operator will be required to only have one or two audio sources on the air at the same time so the need to create an audio mix is minimal.

At times, when the operator is also the announcer, that person may need to talk over the music being played. In such cases the music level will need to be slightly reduced, a process called ducking, so the announcer's voice can be properly heard over the music. Normally an announcer will wear headphones to monitor the relationship of the level of music to the announcer's voice, which then creates an audible reference for knowing how much to duck the music.

All broadcast audio mixing devices have an output called the program channel. This output is the primary audio output for the console and is normally the output that provides the audio for the transmitter. Many audio mixing devices will have a second output termed the audition channel. This output is often used to audition audio that is not scheduled to go on the air. The audition output channel may also be used to feed audio to a destination other than the transmitter, such as a recording device. Some consoles may have an auxiliary output as well which is not used often but may be assigned to a particular destination for a specific purpose from time-to-time. The audio output of these channels can be monitored with speakers or headphones by selecting the appropriate monitor selector switch position on the audio mixing device.

Many audio mixing devices input channels will have output channel assign switches in either mechanical or software form that, when selected, will route that input channel's audio to the device's program, audition, utility, or auxiliary output channels, or any combination of the four. The output channel selector switch for each used input channel must be selected for that channel's audio to be present at the device's specified output. Figure 4-10 shows a typical input channel output assign switch.

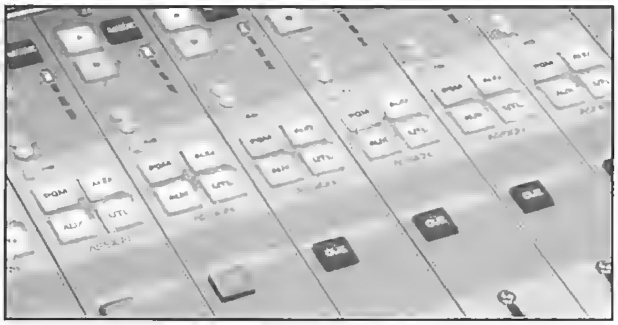


Figure 4-10 Console input channel output assignment switches. Courtesy of Wheatstone Corporation.

Many broadcast audio mixing devices will also have a channel on-off switch on each of its input channels. The switch needs to be in the on position for that channel to actively process audio from the audio source that is connected to that channel. In addition to turning the microphone on and off, the microphone input channel on-off switch may also activate an on-air light, turn off the studio monitor speakers to prevent feedback (squealing) and perhaps mute the studio telephone ringer and other audio-producing devices so they do not sound when the announcer is on the air. Activating the channel-on switch may also start the audio playback unit that is connected to that channel. This type of function is known as a remote start. Figure 4-11 shows a channel on-off switch.

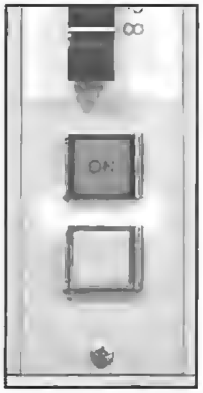


Figure 4-11 A console channel on-off switch. Courtesy of Wheatstone Corporation.

Most audio mixing devices will also have a cue channel. The cue channel is used to preview an audio source before it is put on the air. Each input channel will most likely have some form of a cue on-off switch. When the cue channel is turned on, the audio connected to that channel can be heard through a special speaker that is either built into the audio mixing device or located elsewhere but close to the device. The channel on switch does not need to be activated, the pot does not need to be turned up, nor does the channel output assign switch need to be engaged for the cue circuit to work. The only switches on the device's input channel that need to be activated for the cue channel to operate are its input selector switch and its cue channel on-off switch. Not only can the cue channel be listened to through the cue speaker but on some devices it can be monitored by using headphones connected to the device's headphone jack. Every audio mixing device has a cue channel volume control.

Some audio mixing devices have equalization, which is the ability to adjust the overall tonal sound quality of an audio source. There are normally three ranges, or controls, of equalization on a device input either in hardware or software form. They are low frequency (bass), mid-range (the range of sound between low frequency and high frequency), and high frequency (treble).

The abbreviated wording for these controls is low, mid, and high. Under no circumstances should the operator adjust the equalization of any given audio input on an audio mixing device without first being trained how to do so. Adjusting equalization is an art and it takes practice and skill to learn how to set equalization controls. It is far better to keep the equalizer settings flat, meaning there is no effective increase or decrease in tonal change, than to adjust the controls to the point of diminishing the sound quality. A little bit of adjustment creates a large difference when dealing with equalization. Every audio mixing device has unique aspects.

Most radio stations will have their audio mixing devices connected in such a manner so as to be able to monitor the broadcast air signal in the studio. It is standard procedure to monitor the air signal for assurance of quality and continuity.

4.5 Clocks and Timers

Many audio mixing devices contain built-in or on-screen clocks and timers. Clocks and timers are very important at all radio stations. Most stations broadcast a tight and strict program schedule that requires precise timing. Stations that need to join network programming at a specific time need to have clocks that are accurate to the second. Some stations will use basic clocks and reset them daily as required by using a specific reference for time accuracy. Other stations may have a GPS-connected master clock system that will automatically assure clock accuracy.

Clock timers are used in radio production work for measuring the length of a production as well as for keeping track of the length of the time of a program being aired or for other purposes. Timers come in various formats and are generally very accurate.

4.6 Compressors and Limiters

Following the output of the audio mixing device is usually a piece of equipment called a compressor/limiter. Some audio mixing devices may have this built into their system. This unit automatically controls the level of sound and is sometimes known as an automatic gain controller (AGC). When properly adjusted, the compressor/limiter will decrease the audio by limiting the maximum audio peak levels that it passes. It can also effectively increase low levels of audio. In addition, the limiter portion of the compressor/limiter can be adjusted to limit the output of the device to a certain maximum audio output level. These units are often used to assure a more consistent level of sound being heard by the listener as well as to assure that a transmitter will not over modulate. The FCC places strict limits on a station regarding its modulation level. Modulation will be discussed in greater detail in sections 4.27 and 4.28.

Compressor/limiters are also used in recording studios and professional sound systems for controlling the overall dynamic range of sound. The more popular units are a compressor and a limiter all in one unit. However, they are also manufactured as separate compressor-only and limiter-only units for systems requiring a specific function. Many compressor/limited systems are now available as software packages. The station operator should never attempt to adjust a station's compressor/limiter without first being trained how to do so. Figure 4-12 shows a compressor/limiter.

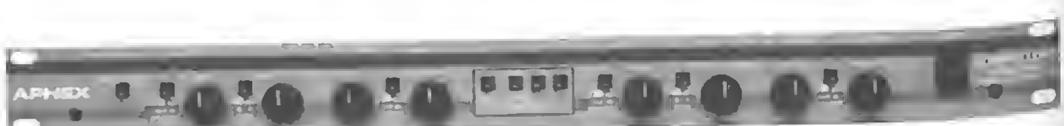


Figure 4-12 A compressor/limiter. Courtesy of Aphex Systems LTD.

4.7 Audio Processors

Compressor/limiters are one type of audio processor, a device that manipulates the dynamic range of a specific sound source. Most if not all radio stations will have an audio processor. This unit, in addition to performing the functions of the compressor/limiter, will have many controls that are used to shape the sound of the station. A rock station will use its audio processor to increase low frequency response in its audio as well as to highly compress the audio, which then makes it sound louder. The station may also use the audio processor to increase its high frequency response to make the audio sound brighter. A jazz station would normally not use as much compression in order to preserve the dynamic range of the jazz music but it may increase its low and mid- range frequency sounds (response) slightly to provide improved clarity in the announcer's voices. A classical music station would most likely use only the compressor/limiter function of the audio processor to achieve minimal audio gain riding. Audio processors used for FM broadcast may include a built-in stereo generator. The function of the stereo generator is explained in section 4.18. The audio processor may be located at the studio or at the transmitter site. Many audio processors use internally based microprocessors specific to the unit's design parameters. Figure 4-13 shows an audio processor with a built-in stereo generator.

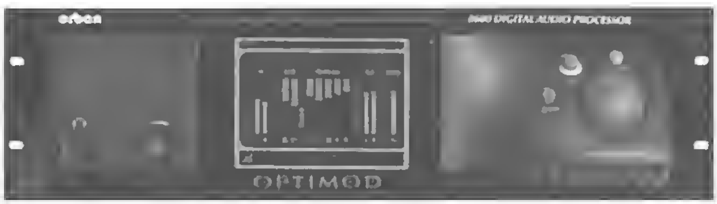


Figure 4-13 An audio processor with a built-in stereo generator. Courtesy of Orban.

Another type of audio processor that is frequently used at AM and FM stations is a microphone processor designed specifically for use with a microphone. It has most if not all of the capabilities of the audio processors described above and it is used to alter the sound of the announcer's voice. Microphone processors may be individual units or they may be built into an audio mixing device. A microphone processor will have the ability to compress and limit the audio of the microphone that it is connected to as well as alter the frequency response to achieve the overall desired sound. Figure 4-14 shows a microphone audio processor unit, also known as a mic processor. A station operator should never make adjustments to any audio processor without first receiving training and authorization from the station's chief engineer.

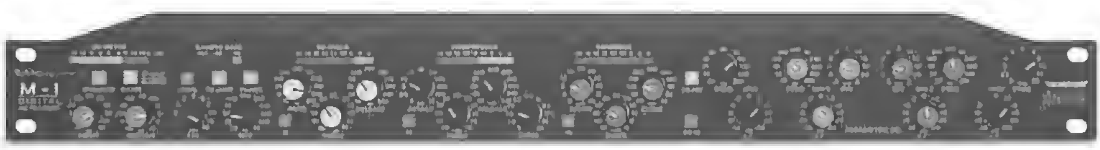


Figure 4-14 A microphone audio processor. Courtesy of Wheatstone Corporation.

4.8 Patch Bays and Electronic Audio Routers

Some stations elect to route various audio sources to and from multiple locations using one of two methods. For many years the use of patch bays was the industry standard. Patch bays are also known as patch panels, jack bays, or jack fields and are used to connect, direct, redirect, or test audio. Patch bays are comprised of horizontal rows of jacks being receptive in nature to having a complimentary matching plug-type connector inserted into a jack. Connectors are often referred to as male and female whereby the female connector (jack) is

receptive and the male connector (plug) is protruding. An example of this is a standard electrical receptacle in a home whereby the receptacle on the wall is considered female and the plug on the end of a lamp cord is considered male. Patch bay jacks are normally of the female type and patch cords used to interconnect the jacks have a male-type connector on each end.

Stations that use patch panels will have audio from various in-studio sources and from external sources connected to one or more panels. The input channels of a studio's audio mixing device may also be connected to the patch bay. A patch bay has multiple jacks of the same type that are used to route audio from various sources to various destinations. It is normally used for a specific purpose to connect source audio to a destination that is not normally connected together. The broadcast standard is to have the audio sources appear along the top horizontal row of jacks on the patch bay and the destinations, such as audio mixing device input channels, appear on the bottom row of the bay's jacks.

Patch bays are often custom-configured and installed to a station's particular requirements. Therefore the station operator will need to spend time with station personnel to learn the bay's purpose and use. A typical patch bay is shown in Figure 4-15. Two types of patch bay cables are shown in Figures 4-16a and 4-16b. Most stations employ the balanced audio patch bay cables of which are the industry standard. Electronic audio routers, also known as switchers, have increased in popularity in recent years. These devices are essentially an electronic audio patch bay. Multiple audio sources and destinations are connected to the audio router. A cross-matrix computer program or dedicated controller enables the station operator to direct audio sources to audio destinations. Many routers have the ability to create and store multiple connecting configurations as well as perform automated audio routing functions. Electronic audio routers are almost always capable of routing analog or digital audio and frequently will also route automated equipment function commands. Many routers are programmed and controlled by software and are often connected for remote access over a station's data network.

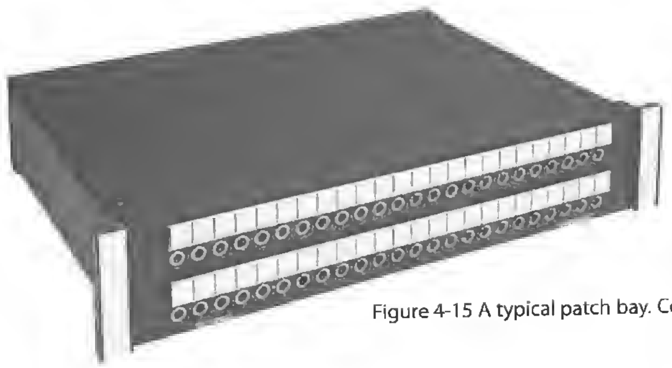


Figure 4-15 A typical patch bay. Courtesy of Switchcraft.

Figure 4-16a A balanced audio patch bay cable.

Figure 4-16b An unbalanced audio patch bay cable.

Some brands of equipment have proprietary software that allows for an audio source to be connected to an analog or digital audio node that is physically resident at any point on the proprietary network system and therefore can be accessed on any audio mixing device; typically a work surface that is also resident on the proprietary network regardless of physical location. Figure 4-17a shows an electronic audio router controller and Figure 4-17b shows an audio router frame.

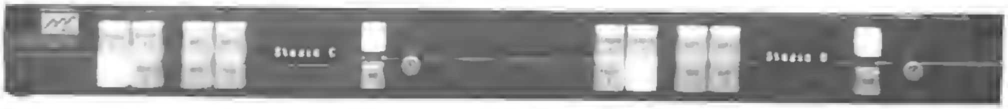


Figure 4-17a An audio router controller. Courtesy of SAS.

Figure 4-17b An audio router frame. Courtesy of SAS

4.9 Audio Delay Units

The FCC prohibits the use of profanity and obscenity over the air. Announcers who have done so as well as stations who have allowed the broadcast of profanity have often received fines from the FCC of several thousands of dollars. Some radio stations, especially those that air live phone calls, may use an audio delay unit. This unit is usually installed in the audio path between the console output and the compressor/limiter input. It delays the live audio by 5 to 10 seconds before it is put on the air. That amount of delay enables the station operator to eliminate unwanted comments from going on the air. Figure 4-18 shows a picture of a program audio delay unit.

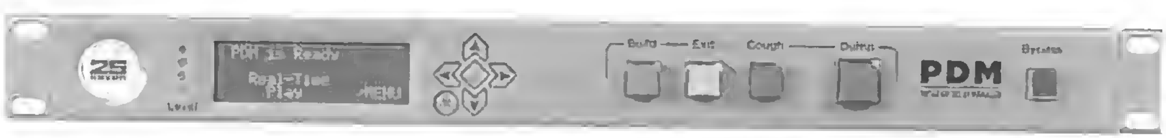


Figure 4-18 An audio delay unit. Courtesy of 25 Seven Systems.

4.10 Audio Record and Playback Machines

Audio recording and playback machines have been used in the broadcast industry nearly since the invention of radio. Wire recorders were popular in the beginning years, then eventually tape recorders of all sizes, shapes and format became the industry standard for many decades. Nowadays, finding a tape recorder of any type in use at a radio station is a rare occasion. Machines that are hard drive-based and use various software programs for audio recording and editing have rapidly replaced the use of tape recorders. Even more advanced are digital audio solid-state recorders–ones that use no moving parts and record the audio onto an on-board memory device. Those memory devices are usually permanently installed in small portable units that are frequently used for field news gathering. In some cases the machine may record onto a removable memory device such as a flash card or USB drive. Machines of this type–when used in either a portable application or permanently mounted–replace reel-to-reel, digital audio tape (DAT), and cassette tape technologies as well as more recent mini-disc and compact disc recording devices. Most digital audio recorders are capable of recording in many of

the popular digital audio file formats. File transfer from these microprocessor-based units is most typically accomplished via USB transfer or other network connectivity methods thereby eliminating the need for audio transfer in real time. As technology continues to rapidly advance, smartphones capable of using a myriad of available audio recording and editing apps have become quite popular for portable recording needs largely because of their ease of use, proven versatility, and the peripheral accessories that have been developed for broadcast-related use.

4.11 Digital Audio Workstations

There are many software programs that are used for manipulating audio. Systems using this type of software are often called digital audio workstations (DAW). They are sometimes networked together so that all files can be available in each of the facility's studios simultaneously. A station operator will need to become well acquainted with the audio equipment and related software programs and systems used at his or her particular station. Figure 4-19 shows a software screen used for recording and editing audio with a digital audio workstation.

Figure 4-19 A digital audio workstation screen. Courtesy of Adobe

4.12 Program Automation Systems

Software-based program automation systems are in wide use at radio stations for the recording and playback of program material. Some stations operate in a fully automated program-delivery mode 24 hours per day, seven days per week while others may operate only part of the day in an automated or semi-automated mode. Often the station's music will be recorded on the hard drive-based automation system for playback, and the announcer will talk between the songs. This mode is called live assist. Other times an announcer will record his or her comments for playback between the songs. This is known as voice tracking. The recording of the announcer's comments, commercials, and music, and the assembly of that into a play list enables the station to automatically play a program.

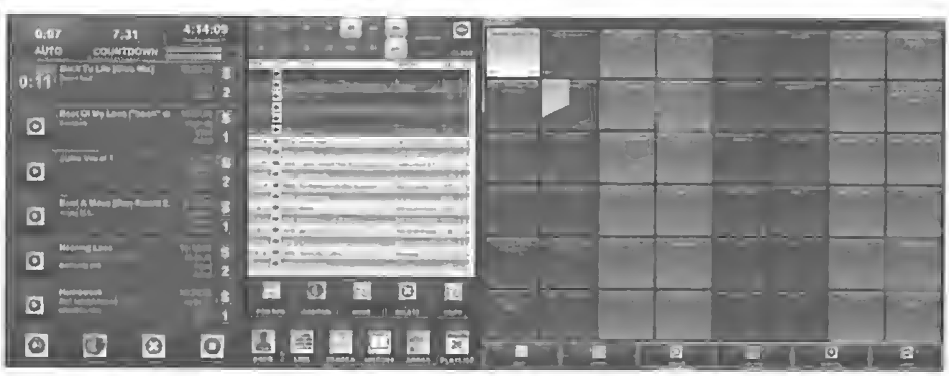


Figure 4-20 A program automation system screen. Courtesy of Enco Systems, Inc.

Stations that use satellite-fed audio sources will frequently record audio from the satellite source for playback at a later time. That process is termed time-delay recording. Prior to airing a newscast, some news reporters will pre-record the newscast onto an automation system to assure mistake-free delivery. Figure 4-20 shows a program automation system software screen.

Program automation computers will sometimes fail. The operator needs to become acquainted with the station's required procedures in the event of a computer failure.

4.13 Telephone Interfaces and Recording Legalities

An electronic device that interfaces between the studio's telephone system and its audio mixing device is termed a telephone interface or telephone hybrid. A telephone interface or hybrid converts the caller audio from a phone line to be fed to the audio mixing device and audio from the audio mixing device to be fed to the caller. Figure 4-25 shows a multi-line telephone hybrid.

The caller's audio output is routed to an input channel on the audio mixing device. A complete mix of the program audio minus the caller's audio (mix-minus) is sent to the caller through the hybrid so the caller can hear the station without having to listen to his or her radio which would result in causing feedback (squealing). Another reason for asking the caller to turn down his or her radio is to eliminate any confusion that may be

Figure 4-25 A multi-line telephone (bottom) with a call director (top). Courtesy of Telos Systems.

caused by the station's use of a program audio delay system. Such systems delay the delivery of the program audio to air by several seconds so, if a caller were to be listening on his or her radio, he or she would speak and then hear his or her voice from the radio several seconds later causing great confusion to the caller.

The mix-minus feed is important because it is the audio feed that contains all the station's programming except the caller's audio. Mix-minus audio is sent to the caller to further eliminate possible confusion to the caller of hearing his or her own voice returned to him or her in the mix, and also to prevent a hollow sound in the caller's audio because of the slight delay introduced by the telephone line. The mix-minus feed is almost always generated from within the audio mixing device.

Some audio mixing devices will have dedicated phone audio input modules that will permit the airing of two or more callers simultaneously. Those input modules have a level control for each caller. Stations that use more than two phone lines will normally use a call director capable of taking multiple phone calls off air, putting the

callers on hold, and then sending a specific caller or callers to the audio mixing device's designated telephone audio input channels. Figure 4-25 shows a call director.

At times stations may have a producer in one room answering and lining up the calls. Call director software may be used with a computer monitor screen in the producer's room and another at the program host location. The screen will display each caller's name, location and, perhaps the topic of his or her question or comment. Figure 4-26 shows a software screen that may be used to log incoming calls.

FCC rule 73.1206 requires that if a caller is to be broadcast, the caller must first be notified of the intent and the caller must give his or her permission to be broadcast. This permission must also be obtained before any recording is done.

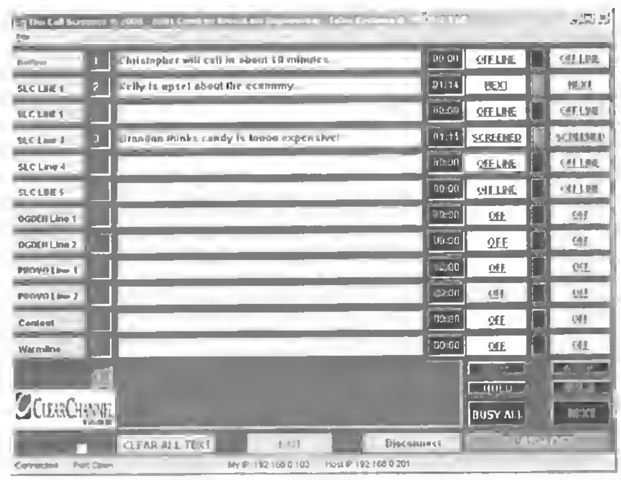


Figure 4-26 A call director software screen. Courtesy of Condron Software.

Another type of telephone interface unit is a POTS (plain old telephone service) codec. Codec is an abbreviation for encoder/decoder. In this case, it refers to encoding and decoding digital audio data files such as those used for the digital transmission of audio. POTS codecs for the transmission of audio over a standard dial-up telephone line are frequently used for sports and other remote broadcasts. They are capable of reproducing relatively high quality audio over a standard phone line. Some phone codec systems require two units; one to be permanently located at the studio and the other to be located at the remote broadcast location. A typical set up would be for one unit to


Figure 4-27 A POTS codec.
Courtesy of Comrex Corporation.

dial the other. When codecs of this type connect, they go through a handshake mode much like that of a computer telephone modem. A standard phone line, a cell phone, or a combination of the two can be used for this purpose. It may be the station operator's responsibility to monitor the connection and to re-establish the call to the remote location if the connection is lost. Figure 4-27 shows a POTS codec.

4.14 Digital Audio Codecs and IP Audio

The use of IP (Internet Protocol) audio codec equipment has quickly become an industry standard in the broadcast industry. IP audio codecs, also known as digital audio codecs, enable high quality audio to be easily and conveniently delivered through equipment designed to be connected to the Internet, cellphones, smartphones, Wi-Fi, local area networks (LAN), wide area networks (WAN), and even satellite delivered circuits. Small portable units are often used by news reporters in the field and also for broadcasting from local businesses, sporting events, festivals or any other location where the origination of audio for broadcast is required. Many units are capable of bi-directional audio transmission whereby audio can be sent from the

Figure 4-28a An IP codec. Courtesy of Comrex

remote location to the radio station and the radio station operator can talk to and send program audio to the person at the remote location for cueing and monitoring. Many studio units also have connection capabilities to POTS or ISDN phone lines. ISDN stands for Integrated Services Digital Network and uses two digital-capable phone lines with a codec connected at each end to transmit bi-directional, full-range or limited frequency response audio depending on the specific application requirement. Many IP audio codecs can accept the connection of multiple audio sources and process various digital audio bit rates and sample formats. There are several technical aspects of digital audio and IP audio codec implementation and operations that go beyond the intended scope of this book. The station operator would be wise to initiate a separate study of the subject as part of their overall scope of study. Figure 4-28a shows an IP codec. Figure 4-28b displays a portable IP audio codec.

Figure 4-28b A portable IP audio codec. Courtesy of Comrex

4.15 Remote Pick Up (RPU) Systems

Remote pick up units (RPU) are sometimes used to send remote broadcasts and news reports from the field to the studio. Typically these units will operate in the 150 or 450MHz frequency range. The FCC authorization (license) for an RPU station will be a separate document. The station will have a remote pick-up unit receive antenna mounted usually on a tower or rooftop at the studio.

The antenna is then connected to a receiver that provides the audio signal being broadcast from the remote site. That audio source is normally connected to an input channel on the station's audio mixing device or router.

A portable transmitter and antenna are taken to the remote broadcast location and set up for scheduled transmissions back to the studio. In certain cases, the transmitter and antenna may be mounted to a vehicle. A typical RPU setup is shown in Figure 4-29. An RPU receiver is shown in Figure 4-30.

Many stations have moved away from using the radio-link RPU described above in favor of using digital audio codecs and cellphones for sending information back to the radio station. The advantage of using a radio link RPU system is that it will, in many cases, provide better sound quality on a more consistent basis when compared to the quality of sound that is obtained from a cell phone.

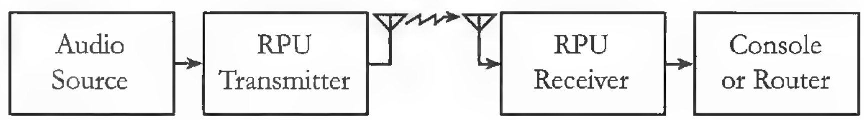


Figure 4-29 Diagram of an RPU system.

Figure 4-30 An RPU receiver. Courtesy of Marti Electronics.

When using an RPU, the person at the remote broadcast location will monitor the station via a personal, portable or other similar radio. When a cell phone or digital codec unit is used as a mix-minus feed of the station audio to the person at the remote location, that audio will eliminate the need for a radio monitor at the remote location. This method is normally used when the remote broadcast is occurring from far outside the station's signal coverage area such as a sportscast that may originate in a far-away city.

At some stations the station operator will be able to communicate with the remote host between the times of the scheduled broadcasts from the remote site by using the audio mixing device's cue channel or other means as may be established by the station's chief engineer. Audio sent to the remote broadcast site is always mix-minus audio meaning that all broadcast audio is sent to the remote broadcast location except for the audio being created by the remote site. Sending station audio to the remote host and being able to talk to that host to establish cues are very important to the success of the remote broadcast.

4.16 Satellite Systems

Almost every radio station will receive audio sources such as newscasts, sportscasts, newswire services, weather data, talk shows and quite often, the station's main programming via a satellite receiver. A satellite dish (antenna) that only receives a satellite signal is known as a downlink. Satellite dishes that transmit a signal to a satellite are known as uplinks. Most radio stations will have a downlink while only a few may have an uplink.

There are two primary satellite receive frequency ranges. C-band uses a larger antenna, usually called a satellite dish, for its reception while Ku-band uses a relatively smaller satellite dish. Both systems are subject to signal loss if the dish becomes covered with snow or ice. Some satellite receive dishes have built-in heaters or covers to prevent snow and ice buildup. Station operators in snowy climates may need to sweep the snow from a satellite dish from time-to-time if the dish is easily and safely accessible.

Ku-band systems are susceptible to signal loss from heavy rain because the moisture in the atmosphere will block the reception of the satellite signal. When this happens, the station operator needs to be prepared to switch to an alternate program source as directed by the station's management. Figure 4-31 shows a C-band(a) and a Ku-band(b) satellite receive dish.

Satellites have multiple carrier frequencies or transponders. Within each transponder will be subcarriers that contain audio program sources. It is those audio program sources that the station operator needs to retrieve for airing or recording. The satellite receiver may automatically switch to the required transponder at the scheduled time or it may be the responsibility of the station operator to do so by using controls on the satellite receiver unit.

Figure 4-31a A C-band dish. Courtesy of Patriot Antennas.

Figure 4-31b A KU-band dish. Courtesy of Patriot Antennas.

Every program received via satellite is first sent to the satellite by an uplink station. Satellite signals are prone to interference from the Sun twice each year close to the time of the equinoxes that typically occur in March and September. During those times, alignment of the Earth with respect to the Sun, and electromagnetic energy radiated from the Sun, interferes with the satellite signal being received. A schedule of these times is always sent to the radio station by the satellite programming provider. When a solar outage occurs, the only course of action is to wait until the interference clears. As an operator, it is your responsibility to fill-in the programming segment with an alternate program source. Check your station's procedures for the appropriate course of action and notification.

Occasionally an uplink may have problems that result in a loss of programming. If programming is not received, the station operator may be required to call the uplink location to verify that it is still transmitting. If the uplink is not having transmission problems, then the loss of satellite audio at a station may be caused by an atmospheric condition or technical failure and, if so, the station's chief engineer or other designated personnel should be immediately notified after the station operator has first put an alternate program source on the air.

4.17 The Studio-to-Transmitter Link (STL)

Many radio studios are located some distance from the transmitter and antenna location (the transmitter site). Sometimes, however, the studios and the transmitter site may be at one location (co-located). Stations that are co-located do not require a studio-to-transmitter link (STL) because the output of the audio mixing device, through the compressor/limiter, is connected directly to the transmitter by a wire within the building.

The STL is a link or the connection between the studio audio output and the transmitter audio input. STL systems can be found in many different forms. Most radio STL systems operate in the 950MHz frequency range. STL systems are either stereo (two audio channels) or mono (one audio channel). To operate a reliable, high-quality microwave STL system, a radio station is required to obtain an FCC microwave license.

A microwave STL system will have its transmitter and transmitting antenna located at the studio. Its receive antenna and receiver will be located at the station's transmitter site where the receiver audio output is connected to the input of the broadcast transmitter system.

Figure 4-32 shows a typical STL microwave system layout. Figure 4-33 shows an STL system transmitter. Figure 4-34 shows a typical STL system antenna that may be used for either transmission or reception.

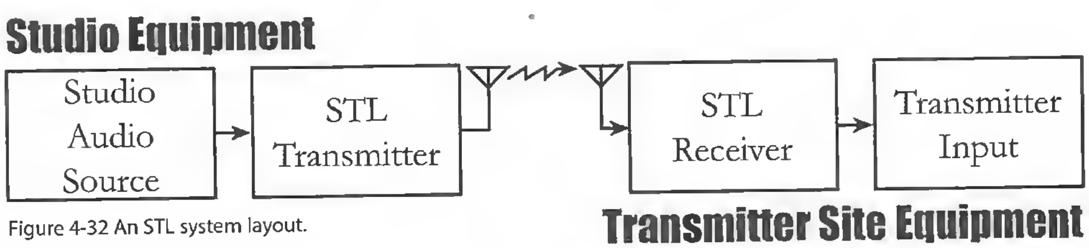
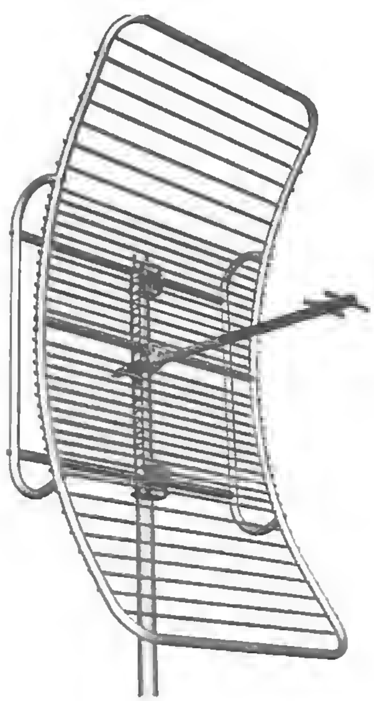


Figure 4-32 An STL system layout.



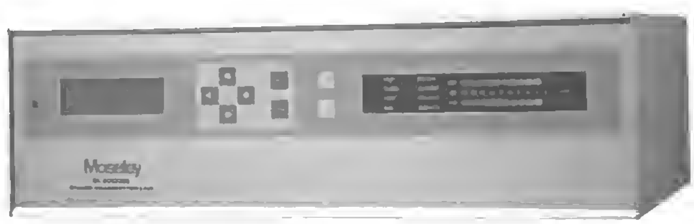


Figure 4-33 An STL system transmitter. Courtesy of Moseley Associates, Inc.

Figure 4-34 An STL system antenna. Courtesy of Kathrein Inc., Scala Division.

A T-1 phone circuit is frequently used in an STL system when terrain is not favorable for a point-to-point line-of-sight microwave transmission. The T-1 line is a high-capacity data path and is capable of carrying 1.544Mbps (megabits per second) of digital data over a long distance. A T-1 STL system also requires the use of a special codec at each end of the line. Because a T-1 line has relatively wide bandwidth capacity the station may also use the line for other purposes such as monitoring and controlling the transmitter. A T-1 line is a fixed path and active all the time.

Another type of STL system that has gained popularity are audio over IP (AoIP) systems that utilize digital audio codecs similar to those described in Section 4.14 on Page 25. Unlike microwave-based STL systems that require expensive antennas and licensing, IP-STL systems only require reliable Internet service or a privately owned local or wide area network (LAN or WAN).

Microwave and VoIP systems are by far the two most popular types of STL systems used in radio. Often stations will have a main and a standby STL system and posted procedures for switching to the standby system in the event of primary system failure if an automatic transfer system does not exist.

4.18 The FM Stereo Generator

FM radio stations that broadcast in stereo will have a stereo generator. This unit may be located at either the studio or the transmitter site. The purpose of the stereo generator is to combine the right and left channel audio from the audio mixing device, through the compressor/limiter into an encoded signal. FM stations that broadcast in mono will not use a stereo generator. Instead, the audio will be connected directly to the audio input of the FM transmitter exciter.

The stereo generator creates an output called the composite signal. That signal is audio in nature and contains the left and right stereo audio as well as a 19kHz (kilohertz) stereo pilot signal. When the stereo generator resides at the transmitter site, it receives its stereo audio source from the studio via the station's STL system and then generates the stereo composite signal that is connected to the FM exciter input. If the stereo generator is kept at the studio, the composite signal for the exciter input is sent to the transmitter site via the STL system. The audio signal of the studio equipment is shown in part of Figure 4-2 on Page 11 from the audio sources to the input of the STL system.

4.19 The FM Exciter

A radio frequency (RF) signal, also known as a carrier, is typically generated by a transmitter. The exciter is the first stage of an FM transmitter. It, in itself, is a low-power transmitter with a power output that typically ranges from 1 to 500 watts. It is the exciter's oscillator circuit that generates the FM radio signal on the station's FCC assigned frequency. The FM exciter is connected to the input of a larger transmitter, one that is capable of generating the required broadcast signal power according to the terms of the station's FCC-issued FM broadcast license.

4.20 FM Antennas, Transmitter Power Output, and Effective Radiated Power

AM and FM stations use very different types of antennas because of the differences in frequency range between the two services. FM antennas are typically multiple elements of a specific size and shape that are mounted onto a single tower. Each element is called a bay so an antenna with four elements would be termed a four-bay antenna. Figure 4-35 shows a four-bay FM antenna.

The number of FM antenna bays and the spacing between the bays determines the antenna's power gain factor. Antenna power gain is the final factor in determining an FM station's radiated power. Every FM station is licensed to operate with a specified effective radiated power (ERP), which is the combination of transmitter power output, transmission line (also known as coaxial cable or feed line) efficiency, and the power gain of the antenna.

As an example, a station that is authorized to broadcast at a power level of 50 kilowatts ERP may have a power calculation as follows. If the station's transmitter power output (TPO) is 30,120 watts and the engineering department has determined that the transmission line's efficiency is 83%, we would then multiply 30,120 watts by 0.83, which tells us that the power to the input of the antenna on the tower is 25,000 watts. Assuming the station's antenna power gain is 2, we would then multiply the 25,000 watts that has been determined to be present at the antenna input times 2 to determine that the station's ERP is 50,000 watts.

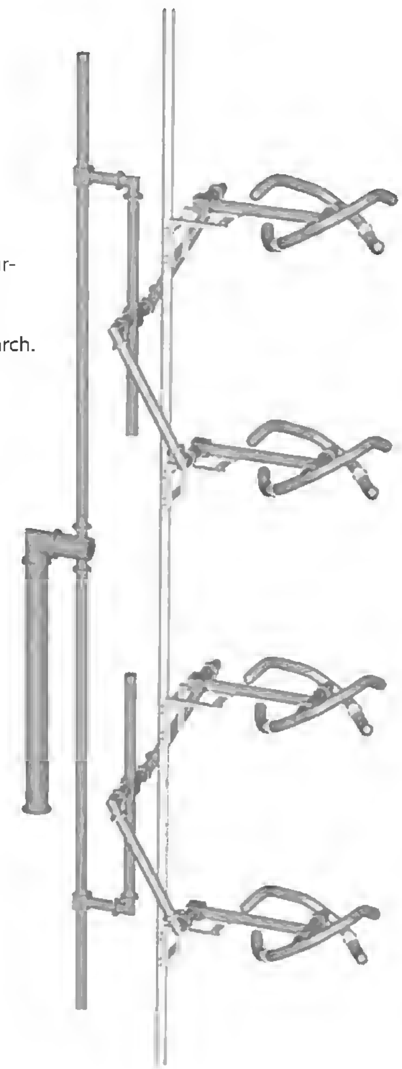


Figure 4-35 A four-bay FM antenna. Courtesy of ERI - Electronics Research.

An FM station is required by the FCC to maintain its transmitter power output between 90% and 105% of its FCC authorized power level. Using those tolerances we can determine that this particular FM station could legally broadcast within an ERP range from 45,000 watts (90% of licensed power) to 52,500 watts (105% of licensed power). Stations try to keep their effective radiated power at their licensed value because they are not permitted to intentionally operate outside the 90% or 105% power level. The combination of an FM station's effective radiated power and its height above average terrain (HAAT) determine the station's signal coverage area. Height above average terrain is defined as the height of an antenna system above the surrounding terrain measured up to ten miles outward from the antenna location in several different directions.

Often FM transmission lines, and some AM transmission lines, will be pressurized with either dry air from an electric pump and desiccate (a device called a dehydrator) or with dry nitrogen. The pressure keeps moisture from entering or accumulating inside the transmission line. The dehydrator or the dry nitrogen supply tank is always located at the transmitter site.

Moisture accumulation in a transmission line can cause a short circuit in the line that would damage the line and possibly damage the transmitter or cause the transmitter to turn itself off. A typical line pressure reading for a transmission line ranges from 3 to 12 pounds per square inch (psi) depending upon the size of the line. The pressure is monitored at the transmitter site by a pressure gauge that is permanently attached to the transmission line. Some stations monitor line pressure with their remote monitoring equipment and in some cases, an alarm will be issued in the event of a low pressure problem. Under no circumstances should a line designed for pressurization be operated for a long period of time without being pressurized, especially in a high-moisture climate. Other forms of transmission lines are foam-filled and do not require pressurization.

4.21 The AM Transmitter

AM transmitters operate in a similar manner to FM transmitters in that the oscillator stage of the transmitter generates the RF signal. It is then increased in amplitude by various amplifier stages to the eventual point of producing the required RF power output. In AM transmission, the modulation (audio) is usually added in the last RF amplifier stage.

Both AM and FM transmitters have doors that provide access to the inside of the transmitter. These doors are equipped with internal interlock switches that will automatically turn the transmitter off if the door is opened. ***CAUTION! Transmitters contain lethal high voltages, currents, or both and should never be opened without the supervision of a qualified broadcast engineer.***

4.22 The AM Antenna

Unlike FM antennas that use elements mounted to a tower, an AM station uses the entire tower as its antenna radiating element. A non-directional AM station, one that radiates its signal equally in all directions, will use one tower with an insulator and an antenna tuning unit (ATU) at the base of the tower.

Antenna tuning units are sometimes known as line terminating units (LTU) or doghouses. The unit may be enclosed in a small weatherproof box or a small building located close to the tower. The antenna tuning unit is designed to properly and efficiently match the transmission line electrical characteristics to those of the tower. Most AM towers are insulated from ground via a base insulator. If the tower of this design was grounded, it would not be able to efficiently radiate the AM signal.

CAUTION! An AM tower should never be touched when standing on the ground while the station is on the air because you can receive an RF burn. Some AM antenna designs use a grounded tower with wires that run up and down parallel to the tower. Most towers, however, are insulated from the ground and are called "hot" towers which means that the RF signal is present over the entire tower. For this reason, the FCC requires a protective fence around all hot AM towers.

Some AM stations are authorized to operate only during daylight hours because their signal, if transmitted at night, would interfere with other AM stations on the same frequency that may be located as far as several hundred miles or more away. These stations are called daytime stations or day-timers.

Alternately some AM stations may be authorized to operate at a certain power level during the day and at a reduced power level at night in order to not interfere with other stations during their nighttime hours of operation. Other AM stations operate using a multi-tower directional antenna system to minimize potential interference.

The term directional relates to the fact that the FCC requires the station to radiate less power in certain directions to keep from interfering with other stations on the same or adjacent frequencies. The combined directions that a station's signal radiates is called its directional pattern, antenna pattern, or signal radiation pattern. Very few directional AM stations have the same radiation pattern because the direction and distances to the station(s) that they need to keep from interfering with (protect) are always different from station-to-station. Some directional AM stations change their operating power at night as directed by the FCC to further minimize potential interference.

Many AM stations operate as non-directional during the daytime hours but as directional at night. That is because AM radio signals travel farther at night due to atmospheric conditions. Other AM stations may operate with one type of directional pattern during the day and another type of directional pattern at night depending upon the requirement that the FCC has placed on a particular station. The daytime pattern is termed the day pattern and the nighttime pattern is termed the night pattern.

An AM directional antenna system may have as few as two towers or as many as ten or more towers. There is no FCC limit on the number of towers that can be used in an AM antenna system (array), but practicality usually limits the number to ten or less. The signal radiation pattern from the directional antenna system is created via the number of towers, the placement of the towers, and the tuning of the towers using a device called a phasing cabinet–often referred to as a phasor. A station operator should never attempt to adjust a phasor cabinet's front panel controls as the tuning of the phasor is a very complicated process that should be left only to trained personnel. ***CAUTIOIN! Under no circumstances should a station operator open a phasing cabinet without the presence of the station's chief engineer or his/her authorized representative.***

The operation of a directional AM antenna system is measured via the use of an antenna monitor that is located at the station's transmitter site. Each tower in the directional antenna system is connected to the antenna monitor to read the current ratio and phase angle of the tower. The FCC-assigned values for each tower's current ratio and phase angle are printed on the station license. Phase angles, measured in degrees, according to FCC section 73.62 of its rules and regulations must be kept to within plus or minus 3 degrees of the station's licensed values. Current ratios must be kept to within plus or minus 5% of the licensed value. The reference tower in an AM directional array will always have a current ratio of 1.0.

An operator of an AM directional station will most likely need to read the phase angle and current ratios of the station's antenna system via the statiou's remote control and monitoring unit, which is explained in section 4.26. Any current ratio or phase angle values that are observed as being out of tolerance should be immediately reported to the station's chief operator or chief engineer as the improper values will result in an incorrect antenna radiation pattern, which may then cause interference to another station.

A non-directional AM station will have an RF ammeter mounted at the base of its tower, usually within the ATU. The reading of that meter is often available at a remote location as well. Each AM station has a tower resistance factor that was measured during the testing of the tower system. That factor is known as R and is always shown on the AM station license. FCC rule 73.51 requires AM power to be determined using the direct method of calculation.

Ohm's law is a formula that is widely used in electronics. In Ohm's law, current is expressed using the letter I and resistance is expressed using the letter R. The direct power calculation formula for an AM station is I squared times R so if the reading of the RF ammeter at the base of the tower is 4 amperes and the license published resistance (R factor) of the tower is 50 ohms we would then square the RF current number of 4 and then multiply it by the R factor of 50 to determine the amount of power present at the base of the AM antenna is 800 watts or 0.800 kilowatts.

The RF ammeter is always located at the base of the AM tower at a non-directional AM station. However, at a directional station, the RF ammeter will be located at the input to the phasor cabinet. The input is the point where the transmitter is connected to the phasor cabinet.

This is known as the common point or common point measurement. This point will also have a published R value. The AM power present at the common point is calculated in the same manner as that of a non-directional antenna with the only difference being the location of the RF ammeter.

The RF ammeter will fluctuate when audio is present on the signal (known as modulation). The meter reading must be taken at a time when no audio is present so the operator needs to closely watch the meter and take the measurement when there is a brief pause in the program audio. Figure 4-36 shows a typical log sheet for an AM directional antenna system including the various operating parameters, as described, that need to be logged -- either manually or by a computer-based monitoring system.

Directional antennas are sometimes used at FM stations to protect a station that may be operating on the same frequency (co-channel) as the FM station or on an adjacent frequency above or below that of the FM station

(adjacent channel). An FM directional station operates that way on a full-time basis. It is not required to switch to a directional pattern at night and then back to a different pattern during the day. Phasing cabinets and antenna tuning units are not used in FM directional antenna installations.

4.23 Antenna Standing Wave Ratio (SWR)

All antennas have a standing wave ratio (SWR). This is the ratio of the power accepted and radiated by the antenna and its associated transmission line system versus the power being reflected (rejected). Standing wave ratio is measured at the transmitter site using a power meter often termed a reflectometer. An efficient antenna system will have very little if any standing wave ratio. A perfect system will have a ratio of one to one (1:1). Most systems will have a SWR between 1.05:1 and 1.1:1.

Station Log

KZZZ 1250 kHz

Date:_______________
Day:_______________
Circle One: CDT CST

TX: 323.555.1234 Password: 4242 Site: 41(TX) 42(Ant.)

Time	PA Volts	Com. Pt. Day	Com. Pt. Nite	Tower 1		Tower 2		Tower 3		Tower 4	
	Ch. 1a Volts	Ch. 5a Amps	Ch. 8a Amps	1b Φ	2b Rat.	3b Φ	4b Rat.	5b Φ	6b Rat.	7b Φ	8b Rat.
Day Example	120.0	21.80-23.60		-32	47	78	72	102	90.5	0	100
Night Example	50		08.05-09.39	14	45	96	42	98	82	0	100

Operator Signature	Sign On Time	EAS RCV Chk Initial	EAS Paper Chk Init. (fill if out)	Sign Off Time

Required Weekly Test Rcvd Time:__________ Initial:_______
Required Weekly Test Sent Time:__________ Initial:_______
Required Monthly Test Rcvd Time:__________ Initial:_______
Required Monthly Test Sent Time:__________ Initial:_______

Comments:______________________________

Chief Operator Log Review: Date:__________ Signature:_______________

Figure 4-36 An AM directional antenna system log.

Different things will cause a high SWR in an antenna system. The most common causes of increases in SWR readings are the station having an antenna that isn't of the proper length, having the antenna tuning unit at an AM station improperly adjusted, or having a problem with the transmission line. In addition, ice build up on an FM antenna may also cause an increase in standing wave ratio. Too high of a standing wave ratio may cause damage to the transmitter. For that reason most broadcast transmitters have a power fold back system whereby the transmitter will automatically reduce its power if it senses a significant increase in the antenna system's SWR. Some FM stations will have heaters (de-icers) built-into their antennas. Those heaters may automatically turn on when needed or they may need to be manually activated. Other FM stations may have radome covers over their antenna in order to prevent ice accumulation. Radio station operators, especially those working at stations located in cold climates, need to be aware of SWR and its possible effects on transmitter power output. Often the station's remote control system and monitoring system is capable of monitoring the standing wave ratio of an antenna system.

4.24 The Transmitter Front Panel

All transmitters have several meters or a computer monitoring screen on their front panels that indicate operating parameters. Each indicator tells a specific story. To understand the story that each indicator tells, it is important to first understand some basic electrical energy terms. Every transmitter has a power supply. The function of that power supply is to take a connection from the incoming electrical service and convert that electrical power into the necessary voltages the transmitter requires to properly function. There are three terms that relate to power. They are volts (voltage), amps (amperes) and watts. Voltage is the electromotive force of the power and is measured in volts or kilovolts whereas one kilovolt would be equal to 1,000 volts. Amperes is the unit of measurement of the rate of the flow of an electrical current. When voltage is combined with current it produces power that is measured in watts or kilowatts (one kilowatt equals 1,000 watts).

In broadcast terms we measure power in two different domains. One domain is the electrical power being consumed by a transmitter. The second is the radio frequency (RF) power output of the transmitter in watts. Electrical power in terms of watts is computed by multiplying the voltage being supplied to the transmitter by the amount of current being consumed by the transmitter. As an example, a transmitter that is operating using a 240 volt electrical source and consuming 50 amperes of current would be said to be consuming 12,000 watts or 12 kilowatts (240 volts x 50 amperes).

There are two methods used to measure a transmitter's RF power output in watts. One method is to read the wattmeter, also known as a power indicator, located on the transmitter front panel. That indicator will provide a reading of the transmitter's power output in watts or, at most stations, in kilowatts. Some transmitter sites may have an external power indicator connected to the transmission line that will provide the same reading. Sometimes the front-panel power indicator on a transmitter will be calibrated in percentage whereas the transmission line indicator will be calibrated in watts or kilowatts.

The reading of a transmitter's power output directly from an indicator is known as the direct measurement of power, also known as the direct method of calculating power. In addition, it may be possible for antenna SWR to be measured from either of the above-mentioned types of power indicators dependent upon the design of the monitoring system.

An alternate method of calculating a transmitter's power output is known as the indirect method. Every transmitter has an efficiency factor that is derived from the difference between the electrical power being consumed by the transmitter's amplifier versus the amount of RF power output being generated by the amplifier. The electrical power being consumed is known as input power whereas the RF power is known as the output power. A transmitter's front panel will have a voltage indicator that is used to measure electrical volts. It will also have a current indicator that is used to measure amperes of current. Some transmitters may use a tube in their final or last RF power amplifier stage where the greatest amount of transmitter power output is generated. The term final tube has been coined within the industry as the name of the last tube in the final RF amplifier stage of a transmitter.

Each final tube has internal elements that cause it to electrically function in the manner necessary for it to generate the required amount of RF energy. The major internal element is called the plate. The final tube operates with a certain amount of plate voltage and a certain amount of plate current. Without plate voltage and plate current the transmitter could not produce its RF power. The plate voltage is almost always measured in kilovolts and the plate current is measured in amperes. To calculate the input power of the tube it is necessary to multiply the tube's input plate voltage times its input plate current. Figure 4-37a shows a transmitter front panel plate voltage meter indicator that reads 3,000 volts or 3 kilovolts. The meter indicator in Figure 4-37b, the plate current meter, shows a reading of 3 amperes of current.

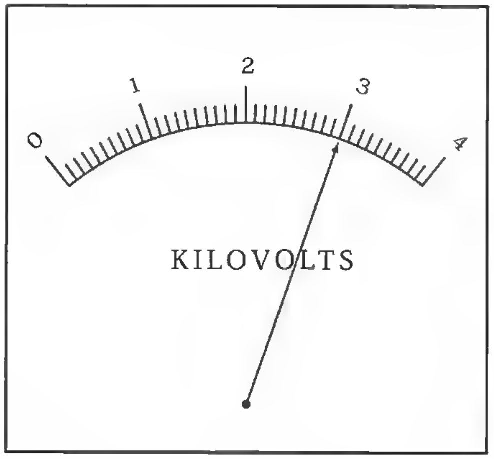


Figure 4-37a A plate voltage meter reading 3 kilovolts.

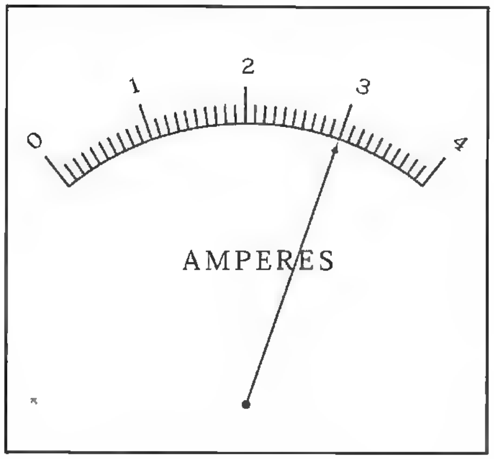


Figure 4-37b A plate current ammeter reading 3 amperes.

Performing the math of multiplying 3000 volts times 3 amperes renders a transmitter power input calculation of 9,000 watts or 9 kilowatts (kW). Every transmitter manufacturer publishes an efficiency factor in terms of percentage for each of its transmitters. For study purposes, let's assume that a particular transmitter's efficiency factor is 81%. The efficiency factor means that a transmitter will output 81% of its power input whereas the remaining amount of power will be lost in dissipated heat. To calculate the transmitter's power output using the indirect method one would multiply the voltage times the current times the efficiency factor.

Therefore, when we multiply the transmitter's 9kW of input power as calculated above by 0.81 (the efficiency factor) we learn that the transmitter's indirectly calculated power output would be 7,290 watts or 7.29 kilowatts.

Many newer transmitters are solid-state designs and use transistors in their final RF amplifier stage rather than tubes. Instead of a plate element like a tube has, transistors have an element termed a collector. On a solid-state transmitter there will be a collector voltage indicator and a collector current indicator. Solid-state transmitters also have some loss due to heat dissipation, therefore they also have a published efficiency factor.

The method of calculation of indirect power for a solid-state transmitter is to multiply its collector voltage times its collector current times its efficiency factor. For example, if a solid-state transmitter has a collector voltage of 100 volts, a collector current of 40 amperes, and an efficiency factor of 87%, its indirect power output calculation would be 3,480 watts or 3.48 kilowatts (100 x 40 x 0.87). The formula for calculating indirect power for a transmitter is shown in Figure 4-38 below.

Plate or collector voltage x Plate or collector current x Efficiency factor = Power output

Figure 4-38 Indirect power calculation formula.

Transmitter front panels may have other indicators that monitor incoming voltage from the power company as well as other operating parameters of the transmitter, however the station operator needs to be primarily familiar with the indicator functions discussed above.

The transmitter front panel will also have a series of switches that operate the transmitter. The three most important switch functions on a tube-type transmitter's front panel are filament on and off, plate on and off, and power raise and lower. Figure 4-39 shows a typical tube-type transmitter front panel switch layout.

To start a tube-type transmitter, the operator first needs to turn on the filament switch. That switch will normally be labeled as filament on and filament off. The filament should be turned on for at least two minutes before the rest of the transmitter is started. This is called the warm up phase of operation. Some transmitters have a time delay relay that prevents the rest of the transmitter from being activated until the filament has warmed up. If the transmitter is on and operational, and the filament is then turned off, the entire transmitter will shut off taking the station off the air. Most transmitters will have an air blower that is used to cool the transmitter during its operation. These transmitters will not function if they do not detect an air flow within their cabinet.

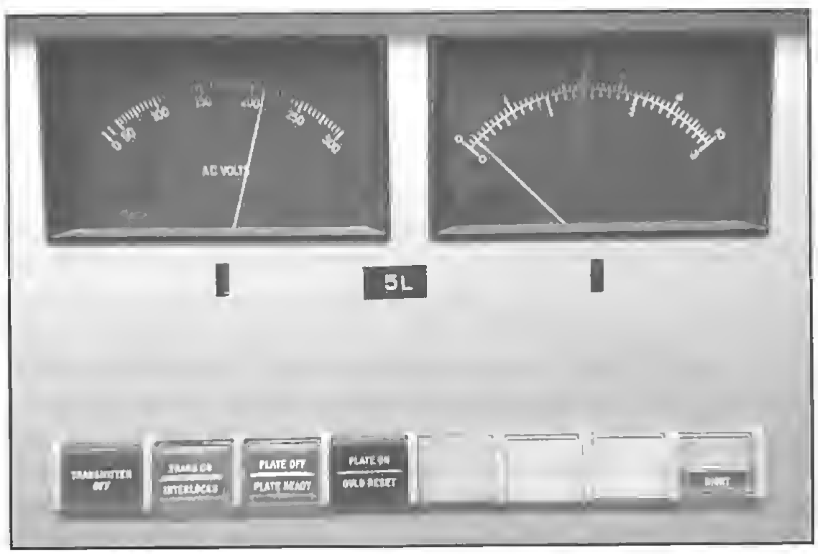


Figure 4-39 A typical tube-type transmitter's front panel switches.

Once the filament has been turned on and it is warmed up, the plate on switch must be turned on for the transmitter to be active (carrier on). The plate switch is normally labeled as plate on and plate off or carrier on and off. The plate on switch applies voltage and current to the plate element in the final tube, which then allows the transmitter to generate its RF signal. Turning the plate off will take the station off the air.

When turning off a transmitter, first turn off the plate and then wait at least five minutes before turning off the filament. This will provide time for the transmitter's air blower to cool the final tube, which normally generates a substantial amount of heat. The proper warming up and cooling down of the tube will lengthen the life of what is generally a very expensive final tube.

The power output of a transmitter is manually adjusted by its power raise and lower switches. Many transmitters have circuits that will automatically keep the power at a pre-determined level within the station's FCC licensed values.

A solid-state transmitter does not use tubes so the transmitter does not have a filament or plate control. These transmitters may still, however, have two controls that are used to turn on the transmitter. The first control may be labeled as control circuits, or similar. Turning this switch on will activate the transmitter's control circuits.

The second switch may be labeled as collector on or carrier on. The term carrier is used in broadcasting to describe the transmitter's output signal. This switch, equivalent to the plate-on switch in a tube-type transmitter, needs to be turned on for a solid-state transmitter's carrier to be active. Solid-state transmitters normally do not require a warm up period but most do have a cooling fan or blower. Some solid-state transmitters are water cooled, in which case a pump system and heat exchangers will be involved. Figure 4-40a shows a tube-type transmitter and Figure 4-40b shows a solid-state transmitter.

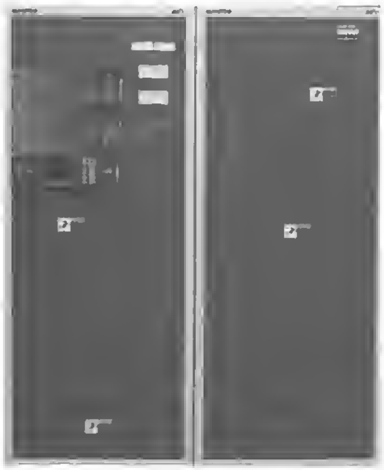


Figure 4-40a A tube-type transmitter.
Courtesy of GatesAir.

Figure 4-40b A solid-state transmitter.
Courtesy of Nautel.

Transmitters may have other indicator and switch functions on their front panels. However, those previously discussed are normally of most importance to a station operator. Each station operator should closely follow the instructions provided by the station's chief engineer or other designated personnel regarding the correct operation of its transmitter. Most transmitters are controlled and monitored via the station's remote control and monitoring system.

4.25 Reading Meters

Meters in a broadcast facility are used to measure many different operating parameters. It is important that they are read correctly. As discussed earlier, there are VU meters on an audio mixing device. There are typically meters on a transmitter and on a transmitter remote control and monitoring system that are used to measure voltage, current, and power. Meters that are used in broadcasting are either analog or digital. The digital type displays numbers and, when relevant, a decimal point. This is known as a direct readout or as a digital readout. Analog meters have a faceplate with a scale of numbers imprinted on the plate. That is called the meter scale. The analog meter also has a needle or pointer that will move when in operation to indicate the reading or status of the circuit in which the meter is connected.

When reading a digital meter it is important to understand the significance of the reading and the electrical term that it represents. A meter that is labeled as volts and reads 7245 would tell us that there are 7,245 volts (7.245 kilovolts) present in the circuit that the meter is monitoring. If the meter was labeled as kilovolts (kV) and read 7.245, it would be equal in voltage level to the prior example.

Figures 4-41a and 4-41b below show two digital meters that reflect the stated examples used in this example. The station operator always needs to pay close attention to the labeling of the meter and to the decimal point.

Analog meters require greater attention to detail when being read. Examples of three analog meters that may be found on a transmitter are shown in Figures 4-42a, b, and c. One meter is labeled as reading kilovolts of voltage, the second is labeled as DC amperes of current, and the third is labeled as reading kilowatts of power.

The meter's scale in Figure 4-42a is labeled as measuring kilovolts (kV). The label above the meter on the transmitter's front panel is labeled as plate voltage so this meter is measuring the plate voltage of a tube-type transmitter. Its scale is calibrated from 0 to 4 kilovolts with 10 increments in between each kilovolt. The 4 kilovolt mark is termed the meter's full scale. Each increment or division on the meter represents 100 volts (1,000 divided by 10) thus 10 increments of 100 volts each equals 1 kilovolt. The meter reading shows two increments above the 3 kilovolt mark. Since each increment is equal to 100 volts then two increments are equal to 200 volts. Therefore, the reading would be 3,000 volts plus 200 volts, which equals 3,200 volts or 3.2 kilovolts.

The meter's scale in Figure 4-42b is labeled as measuring amperes and the label above the meter is plate current. This meter is used to measure the plate current of a tube-type transmitter. The meter scale is calibrated from 0 to 4 amperes of current so its full scale reading would be 4 amperes. There are 10 increments in between each ampere indication. Each increment would then be equal to 10% of one ampere or 0.1 amperes (1 divided by 10).

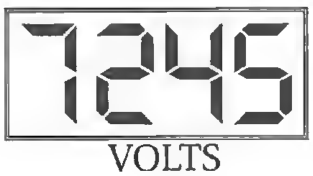


Figure 4-41a
A digital meter labeled in volts and reading 7,245 volts.

Figure 4-41b
A digital meter labeled in kilovolts and reading 7.245 kilovolts.

The meter is reading above 2 amperes on the scale so we know that we have at least 2 amperes of plate current present in the transmitter. We see that the meter pointer, also known as its needle, is resting on the seventh increment between the 2 ampere and the 3 ampere reading. Because each increment is equal to 0.1 amperes then seven increments would be equal to 0.7 amperes. So, we add the 2 amperes plus the 0.7 amperes to determine a reading of 2.7 amperes of plate current.

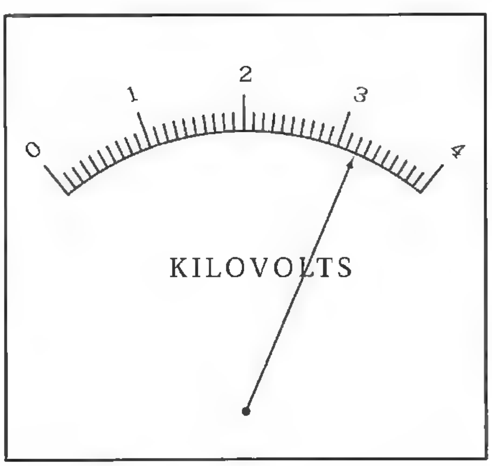


Figure 4-42a
An analog meter reading a plate voltage of 3.2 kilovolts.

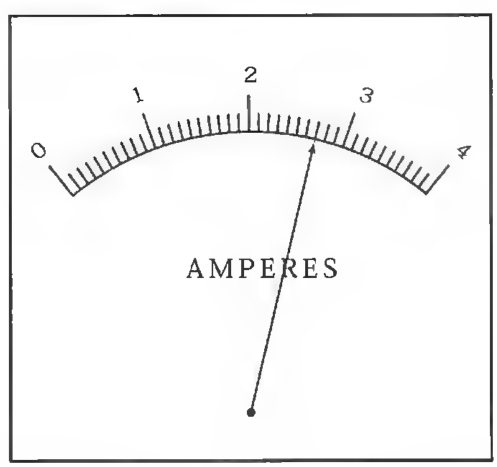


Figure 4-42b
An analog meter reading a plate current of 2.7 amperes.

We now know that the transmitter has a plate voltage of 3.2 kilovolts and a plate current of 2.7 amperes. Next we move to the meter shown in Figure 4-42c, which is labeled as kilowatts and its label on the transmitter reads power output. The purpose of this meter, known as a wattmeter or power meter, is to provide a direct power output reading of the transmitter's power being generated and sent into the transmission line system. We see that the meter is calibrated from 0 to 8 kilowatts. There are also ten increments in between each kilowatt indication on this meter as well. If 10 increments are equal to 1 kilowatt then 1 increment would be equal to one-tenth of a kilowatt or 100 watts. We see that the meter is reading between 6 and 7 kilowatts so we know that our transmitter power output is at least 6 kilowatts. Since the meter is above the ninth increment we know that we have at least 900 watts to add to the 6,000 watts that we already know therefore showing at least 6,900 watts of transmitter power output. Mentally divide the space between increments to estimate the value of the division. In this case, divide it in thirds to estimate that the meter reads up to one third of the imaginary increment. One-third of 100 is 33. Figure 4-43 shows this concept, termed as interpolating, in detail with each division divided into three segments.

Power Output

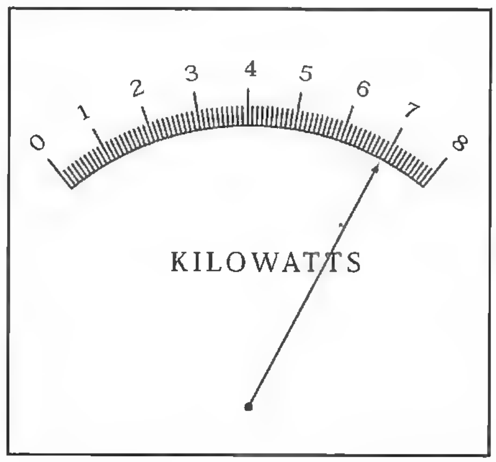


Figure 4-42c An analog meter reading a power output of 6.93 kilowatts.

We now add the 6,000 watts plus the 900 watts plus the 33 watts that we have interpolated by estimating the amount between the two increments in order to achieve a transmitter power output reading of 6,933 watts or 6.933 kilowatts.

Power Output

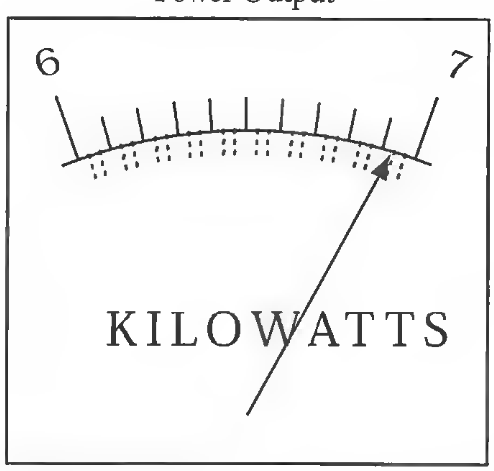


Figure 4-43 Detail of a meter scale showing in dashed lines the imaginary divisions between the marked increments.

Direct readout digital meters are much easier to read, however most stations will have analog meters on their transmitter or remote control and monitoring unit. The station operator should practice reading meters and obtain a high skill level in so doing to obtain the most accurate information from a meter reading. Most transmitter meters will be read by using the station's remote control and monitoring system as described in section 4.26.

4.26 The Transmitter Remote Control and Remote Monitoring

As mentioned earlier in this book some studios are co-located with their transmitters. Usually at co-located facilities the transmitter is monitored and controlled at its front panel, by an on-site extension meters system or by a computerized system. In situations where program automation systems may be in use and no one is at the studio (unattended operation), or if the transmitter is unattended because the studios are located several miles from the studio, a transmitter remote control unit and monitoring system is then required. The remote control and monitoring system will enable the metering of the station's operating parameters, indicate the status of operating circuits, and facilitate control commands for the transmitter and associated equipment. The FCC requires every transmitter to be monitored and to have the capability of being controlled. This is commonly referred to as monitor and control. The location where that is performed is called the control point, which at most stations is the on-air studio. Transmitter remote control and monitoring systems consist of a unit at the transmitter site and a unit at the studio. They are usually connected together via the station's STL and its transmitter-to-studio link (TSL) system providing for full-time, always connected monitoring or via a standard phone line that enables the station operator to call the remote control system. There are several types of remote control and monitoring systems. Most are now computerized in some manner. Remote control systems can be based on hardware designs with dedicated devices for the studio and transmitter sites, or they can be based on a computer platform. Figure 4-44 shows a dedicated-hardware remote control unit.

Figure 4-44 A dedicated-hardware remote control unit. Courtesy of Burk Technology.

A dedicated-hardware unit may have either an analog or a digital meter on its front panel that is used for measuring the transmitter's various operating parameters including voltage, current, and power. The unit may also have controls on its front panel to select the specific meter reading that is to be taken. The controls are also used to issue commands for various functions that include turning the transmitter on or off, switching to a standby (auxiliary) transmitter if the main transmitter should happen to fail or, perhaps, switching the operating parameters of an AM directional antenna system as required by the FCC when the station goes from operating in a day mode to its night mode, and vice versa.

Remote control units located at AM stations that use a directional antenna system may also have switches on the front panel that allow selection for the monitoring of the station's directional antenna system current ratios, phase angles, and common point current. The remote control system should also function in such a manner that it would permit the station operator to increase or decrease the transmitter's power output as required.

Another primary function of the remote control and monitoring system is the monitoring of the station's tower lights as is required in Part 17 of the FCC Rules. Chapter 5 describes this in greater detail. Out-of-tolerance monitoring alarm equipment may also be connected to the remote control and monitoring system. If an alarm were to occur, the operator may be required to try to correct the problem by using the functions found on the remote control unit. If the out-of-tolerance problem cannot be corrected, it should then be immediately reported to the station's chief engineer or chief operator according to the instruction received by the operator from the station's personnel. In addition to providing meter readings and the functions mentioned above, the station's chief engineer may have other functions connected to the remote control and monitoring unit that need to be monitored or controlled. While many of the functions mentioned are becoming more and more automated, it is still important for the station operator to understand them.

Rather than having a remote control unit as described above at the studio there may be a computer monitor that indicates all the operating parameters including metering and status of the station's transmitting equipment. Figure 4-45 shows a computer monitor remote control and monitoring screen.

Figure 4-45 A computer monitor remote control and monitoring screen. Courtesy of Burk Technology.

The studio remote control and monitoring system computer may be connected full-time to the remote control and monitoring system computer at the transmitter site via the station's STL and TSL systems, the Internet, or the station's private network–any of which will provide the most-recent set of operating parameters.

When connected to the computer at the transmitter site, the functions of a remote control and monitoring system as mentioned above are typically done via keyboard commands and/or mouse clicks, or the use of a touch-screen monitor. Often the studio computer will be programmed to print a log of the operating parameters registered at a particular time. That information is then kept with the station log. Some stations will store that information on a hard drive rather than printing it. The information would only be printed if and when required. The logs are kept to show that a station's operation has been in compliance with FCC rules. Logs are required to be kept for two years under FCC rule 73.1840. It is the responsibility of the station's chief operator to review the logs for accuracy on a weekly basis.

A remote control and monitoring system that connects the transmitter computer to the studio computer by placing a phone call is called a dial-up remote control system. Some dial-up computer systems located at the transmitter site will, at a predetermined interval, call the computer at the studio site to log a set of station operating parameters. In addition, this type of system also enables the station's operator to call the transmitter computer if information needs to be known regarding the station's technical operating parameters or to otherwise perform a technical function. These types of systems have a synthesized voice that will speak the information desired based on commands that are entered using the buttons on a touch-tone telephone. A dial-up system will also call the station's operator or other designated person, such as the station's chief engineer if an out-of-tolerance condition exists or if the station is off the air. This type of

system also has the capability of printing a log of operating parameters or storing the information on hard drive in a manner similar to a full time connected computerized remote control and monitoring system. When using a dial-up remote control system, every touch-tone phone becomes a control point. The system is protected with a pass code that must be entered when the connection is first established.

Dial-up systems that automatically monitor and control a transmitter site and call a designated person if there is a problem are termed automatic transmitter systems (ATS). The FCC used to require that all remote control and monitoring systems, regardless of type, remain calibrated to within 2% of the actual operating parameter. However, section 73.1350(c)(2) now requires only "reliable indications," although maintaining the former 2% accuracy requirement would certainly be an acceptable tolerance. It is usually the job of the chief engineer or, sometimes, the chief operator to keep the remote control and monitoring system correctly calibrated.

When that person is at the transmitter site looking at the actual operating parameters on the transmitter he or she may call upon the station operator to find out what the studio unit is reading, compare the two, and then make whatever adjustments necessary in order to assure proper remote control system calibration. No two remote control and monitoring systems are exactly the same. If a remote control and monitoring system fails, the operator should immediately notify the station's chief engineer. It is the responsibility of the station operator to learn the proper operation of the remote control and monitoring system at the station where employed.

The development of remote control and monitoring systems that utilize smart phone and tablet technology have become of interest to many stations. Their use is taking the monitoring and control of radio stations to a new level. However different the technology may be, the monitoring and control concepts remain the same.

4.27 Frequency and Modulation

Frequency is defined as the number of times per second a wavelength repeats itself. The unit of frequency measurement is the hertz (Hz). AM frequencies are measured in kilohertz (kHz) (thousands of hertz) and FM frequencies are measured in megahertz (MHz) (millions of hertz). FM frequencies are higher than AM frequencies because they have a higher number of wavelength repetitions per second.

The frequency on which a station transmits is assigned by the FCC. AM stations broadcast in the 540 to 1700 kilohertz range or 540,000 hertz to 1,700,000 hertz. This is known as the AM band of frequencies or AM band. An AM station broadcasting at 1700 kilohertz (1,700,000 hertz) could also be said to be broadcasting at 1.700 megahertz. FM radio stations broadcast in the frequency band from 87.9 to 107.9 megahertz.

Frequency tolerance is important in broadcast stations. The FCC sets the limits of frequency tolerance at plus or minus 20 hertz for AM stations and plus or minus 2,000 hertz for FM stations.

An AM station would therefore be permitted to broadcast on a frequency up to 20 hertz above the station's FCC assigned frequency to 20 hertz below its assigned frequency, although every attempt should be made to maintain the operating frequency as close to the assigned frequency as possible.

An FM station would be permitted to broadcast on a frequency from up to 2,000 hertz above the station's FCC assigned frequency to 2,000 hertz below that frequency. Some radio stations will have a frequency monitor in use or use a unit called a frequency counter to assure that their station is operating within the correct frequency tolerances. Frequency monitoring is discussed in Section 4.28.

Modulation is the process of modifying a radio station's carrier (RF signal) by injecting audio onto the carrier. Without modulation there would be no sound on a radio station. AM derives its name from its use of amplitude modulation. Amplitude refers to a varying of the carrier level that is caused by the addition of audio onto the carrier. An AM station has two measurements of modulation, the positive and the negative peak, which refer to

the amount of the modulation of the waveform. The maximum permissible modulation under FCC rule 73.1570 (b) for an AM station is 125% positive peaks and 100% negative peak modulation. The FCC also limits an AM station's audio frequency range to between 50Hz to 10kHz whereas an FM station can broadcast with a frequency response from 50Hz to 15kHz. This is one of several reasons for the difference in the sound quality of an AM station when compared to an FM station.

FM stands for frequency modulation. FM stations are modulated differently than AM stations. When audio is applied to an FM carrier its frequency is shifted, or deviated, by plus or minus 75 kilohertz from the station's unmodulated operating frequency. The amount of deviation is dependent upon the level and frequencies of the sound that is being transmitted. There is no physical limit to how heavily an FM signal can be modulated. The FCC Rules, however, limit the amount of modulation on most FM stations to 100%. An FM station that is modulating at 100% would be deviating its frequency plus or minus 75kHz from its assigned frequency. If an AM or FM station exceeds its FCC assigned limits of modulation it is said to be over modulating and may cause interference to stations on adjacent frequencies (channels) as well as produce a distorted sound on listener's receivers.

In some cases, an FM station may transmit additional subcarriers. In such cases, small amounts of additional modulation are permitted by the FCC. Subcarriers are typically used for commercial applications including paging, background music transmission, or data transmission. Reception of a subcarrier can only be done using a special receiver. Subcarriers are typically referred to as SCAs, an abbreviation for subsidiary communication authorization. The FCC once required that a station have authorization to broadcast a subcarrier signal; a practice that ended in 1984. Regardless, the SCA term stuck. The operation of a subcarrier normally does not require the intervention of an operator unless otherwise instructed.

4.28 Monitoring Frequency and Modulation

A station's frequency may or may not be monitored at the radio station. It is the responsibility of the chief engineer or chief operator to be sure a station is transmitting on its assigned frequency. That may be done with a frequency counter located at the transmitter site or with a frequency monitor located at the studio. Figure 4-46 shows a frequency monitor.

Figure 4-46 A frequency monitor. Courtesy of Belar.

A frequency monitor will show the departure of the station's main carrier frequency from its assigned frequency. It is the studio frequency monitor that most station operators will need to become familiar with. Most frequency monitors will display, in hertz or kilohertz, the difference between the assigned carrier frequency and the station's actual frequency.

If a station with an assigned frequency of 88.5MHz has a frequency monitor that is reading minus 1.2kHz we would then subtract the 1.2kHz from the assigned 88.5MHz frequency to determine that the station's carrier is actually operating at 88.4988MHz, which is legal as it is within the plus or minus 2,000Hz (2kHz) tolerance. If the frequency monitor shows minus 2.5kHz we would subtract that from the station's assigned frequency to determine that the station's carrier is transmitting at 88.4975MHz, which is illegal as it is outside of the permitted plus or minus 2kHz tolerance limit.

The frequency tolerance of an AM station differs from that of an FM station in that an AM station's permitted frequency tolerance is plus or minus 20Hz. The methods for monitoring and computing the actual operating frequency are, however, the same as they are for FM stations. Any out-of-tolerance frequency condition should be immediately reported to the station's chief engineer or chief operator.

Modulation is monitored on a modulation monitor that is usually located at the studio. An FM stereo modulation monitor will typically have two or three meters if it is an analog unit. One meter will read the left channel modulation, one the right channel modulation, and one the total modulation. The total modulation is the sum of the left and right channels' modulation plus the amount of stereo pilot signal and other subcarriers being transmitted. AM stations will have a modulation monitor with only one meter unless they are broadcasting in AM stereo.

There are also digital modulation monitors that display modulation readings on the front panel of the monitor or on a computer monitor screen. Figure 4-47a shows an analog modulation monitor and Figure 4-47b shows a digital modulation monitor.

Figure 4-47a An analog modulation monitor. Courtesy of TFT.

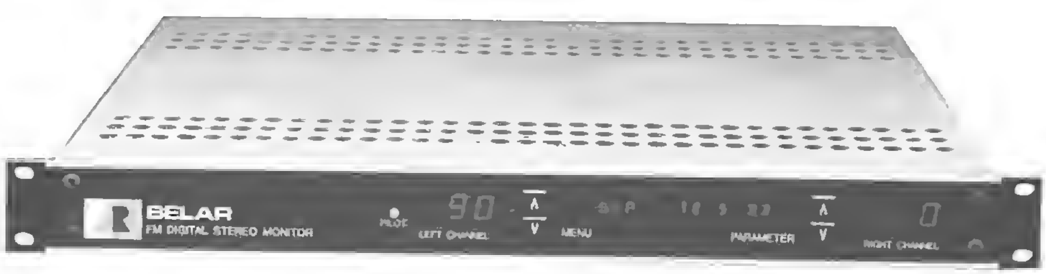


Figure 4-47b A digital modulation monitor. Courtesy of Belar.

4.29 In-Band On-Channel (HD Radio) Broadcasting

In-band, on-channel (IBOC) AM and FM radio broadcasting, also known by the brand name HD Radio, is a broadcast technology that has been adopted by many AM and FM stations. That technology enables stations to broadcast up to at least four additional program channels within the station's existing signal. The broadcast of an IBOC signal requires an Importer unit typically located at the studio, and that facilitates the management of the station's additional IBOC (HD Radio) audio channels. An STL system capable of digitally transmitting an IBOC data stream to the transmitter site is required and is normally connected to an Exporter device located at the transmitter site. The exporter combines the station's main program audio with the additional HD Radio audio channels into a common data stream that is then connected to an IBOC broadcast capable transmitter exciter. Station operators may be asked to assist with the production and monitoring of the station's additional HD Radio IBOC broadcast channels. The additional channels can be enjoyed by anyone using an HD Radio-capable receiver. Those radios are typically available at leading electronic retail stores and at various on-line vendors. HD-Radio capable radios will also easily receive a station's analog signal.

5

Tower Light Monitoring

5.1 Tower Lights and Their Monitoring

Every radio station tower over 200 feet in height is required to have tower lights. Towers that are painted with alternating bands of orange and white paint are required to have their tower lights working only at night. Towers that are not painted are required to have lights that operate 24 hours per day. The tower lights on a given tower are designated as beacons and obstruction lights. The top beacon light is the top-most light on a tower and will flash on and off during operation. On taller towers, there will be a flashing beacon about one-half way up the height of the tower. That beacon is termed the middle or bottom beacon. The beacon lights may be either incandescent or strobe type. Additionally there will be a series of smaller and steady-burning red lights at various levels on a tower. These lights are known as side marker lights or side lights. Multiple levels of marker lights would be known as top markers for the highest level and bottom markers for the lowest level. On a triangular tower there will be a marker light on each leg of the tower per level. A monopole type tower (single pipe) will normally have two marker lights per level. Figure 5-1 shows a typical tower light layout.

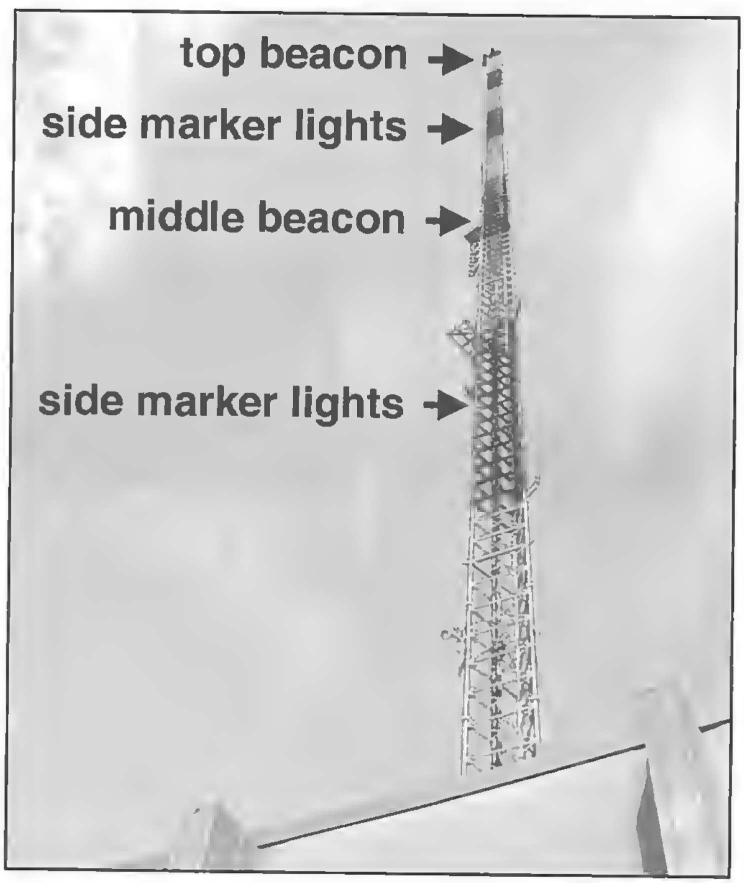


Figure 5-1 Tower light locations and designations. Photo by Chriss Scherer, CPBE, CBNT.

A tower greater than 200 feet in height without the orange and white bands of paint is required to have tower lights that function during the day and night. During the day white strobe lighting is used. At night red obstruction lights or reduced-intensity white strobe lights are typically used.

FCC rule 17.47 requires that the tower lights be observed for proper operation once each 24-hour period. Some stations will have an automatic tower light monitoring system so, at those stations, there would not be a reason to observe the lights daily unless otherwise directed by station personnel. The tower lights will normally come on or the strobe lights will normally go into the night mode at dusk each evening. It is important to observe the operation of the lights, for stations that require such, at dusk or as soon thereafter as possible. The station operator should become familiar with the format of the lights on the tower under normal operation. Stations that observe their tower lights on a daily basis will have a daily log whereby the date and time of the observation is entered along with the name of the person doing the observation. This log is normally part of the station log. A tower light inspection log is shown in Figure 5-2

RADIO STATION WXYZ
123 Anywhere Street
Hometown, USA 55555
91.7 FM – 3 kW ERP

TOWER LIGHT INSPECTION LOG

DATE	TIME	INITIALS	CONDITION

REMARKS

Figure 5-2 A tower light inspection log.

All tower lights are important, however it is the top beacon or the top set of marker lights that are of greatest importance. The Federal Aviation Administration (FAA) requires that a tower light outage or other improper function be reported to the nearest FAA flight office within 30 minutes of the observation of the outage if the problem cannot be immediately corrected. A tower beacon that is on but not flashing is considered to be non-functional and should be reported to the FAA. The outage should also be brought to the attention of the station's chief engineer or chief operator as soon as possible. A marker light outage should also be reported. The report should include information about which level (top or bottom markers for example) and which direction (northeast leg of the tower or south leg for example). The date and time of the observed outage or malfunction along with the station operator's name should be entered into the tower light log. The time, date, and station operator's name as well as the name of the person at the FAA to whom the problem was reported should also be noted on the log when a malfunction is reported.

Some stations with automatic tower light monitoring devices will have those devices report a tower light problem to the station's operator through the station's remote control and monitoring system. Alarms of this type should be considered a tower-light problem, reported accordingly, and also noted on the tower light log or on the station's operating log.

It is the station operator's responsibility to become familiar with the station's tower location and lighting system as well as that particular station's specific procedure for the monitoring of tower lights and the reporting of outages. The station operator will need to know the phone number of the nearest FAA flight office, the geographic coordinates and FCC Antenna Structure Registration (ASR) number of the tower, and its height when reporting a tower light problem. This information should be provided to the operator by the station and kept at a location where it will be readily accessible when needed. The information also appears on the station's FCC license. The ASR certificate should be posted with the station license.

6

The Emergency Alert System (EAS)

6.1 The Emergency Alert System (EAS)

It is important for the station operator to understand the national Emergency Alert System (EAS) and the EAS equipment at the station. FCC rule 11.35 requires that each station have a properly installed and functioning EAS encoder/decoder. The encoder/decoder is a unit that is capable of deciphering (decoding) encoded incoming EAS messages and of encoding outgoing EAS messages. An EAS encoder/decoder is shown in Figure 6-1.

Figure 6-1 An EAS encoder/decoder. Courtesy of Sage Altering Systems

The EAS encoder/decoder has the ability to send messages specific to a targeted geographic area. Every EAS message transmitted has, at its beginning, a data stream known as the header followed by a two-tone alert signal followed by a voice or text message followed by an end-of-message data stream. The EAS message originator encodes the message with the originator's name, time, and date (termed the header), the specific message, and the time and date of the end of the message transmission. The EAS unit at the station receives the encoded message from the originator and decodes it accordingly.

Each radio station is required to monitor at least two other radio stations in its operational area. All stations within a particular operational area are required to monitor the Local Primary 1 (LP-1) and the Local Primary 2 (LP-2) stations for that specific area. Stations must also monitor via Internet connection the FEMA managed IPAWS Open Platforms for Emergency Networks (IPAWS-OPEN) system that collects Common Alerting Protocol (CAP) alerts when issued by authorized public organizations and then distributes those alerts through the EAS system.

The operational areas and the station monitoring assignments are contained within the state or local EAS plan, which should be available to the station operator for familiarization. Additionally, each station is required to have a copy of the most recent FCC EAS handbook at the control point of the station and as close to the EAS equipment as possible.

The LP-1 and LP-2 stations frequently originate or relay a test or emergency message. Many stations will also monitor the local National Weather Service broadcast with their EAS receiver since the National Weather Service may broadcast severe weather warnings via the EAS system. Other local and government organizations such as law enforcement and emergency management agencies also have the capability to issue emergency information for broadcast over the EAS system. On a national level, and the primary reason that the EAS system was created, the President of the United States has the capability of broadcasting important information to the nation via the simultaneous use of EAS units located at every station throughout the country. A message of this type is known as an Emergency Action Notification (EAN). EAN messages are required to be aired immediately and take precedent over all other messages.

The EAS is most frequently used for the disbursement of weather and civil emergency information although there are many event codes that may be used to activate the system including codes for the broadcast of earthquake information in areas that experience such. A relatively new use for the EAS system is the rapid disbursement of missing or abducted child information to the station's listeners. This is called an AMBER alert. The use of EAS for AMBER alerts is defined in an area's state or local EAS plan.

EAS units are required by FCC Rules to be installed at a radio station in such a manner so as to enable certain messages received to be automatically rebroadcast over the station. The unit must be connected so that it will, when activated to transmit a message, automatically disconnect the studio audio mixing device program audio feed going to the transmitter and then connect the EAS unit to feed its audio to the transmitter. This is known as program interrupt.

At the discretion of the station's management and its chief engineer, the EAS unit can be programmed to accept and automatically rebroadcast emergency messages within a given time frame, store the message for later airing (timed delay), or ignored. In an ignore mode, the message will not be processed other than to provide a notation on the EAS unit's logging device that provides specific information about the message. That information is important as it informs the station operator about the nature of the message. All EAS activity received and/or sent by the station must be accurately documented and stored in a manner that is determined best by the station. That information is kept and made available in the event of an on-site FCC station inspection.

The EAS unit will typically store an audio file created by the message's originator that provides the details of the emergency. It is that audio message that is normally rebroadcast by stations. For stations that are unattended, the message must be automatically relayed (rebroadcast) over the air to the listening public. Attended stations will have the opportunity to listen to the message, stop it from being aired by operating certain controls on the EAS unit, and then read the emergency message live over the air. Another option, dependent upon station policy, is to air the EAS message received but delay its airing by a certain period of time. Either of the last two options provides the operator with some latitude as to where to place the broadcast of the EAS message within the station's programming schedule. Remember that time is of the essence with some warnings such as tornado or flash flood warnings. The only EAS information that is required to be rebroadcast are EAN messages, emergency action termination (EAT) messages, and the required monthly test (RMT). Most stations, however, rebroadcast many emergency messages received over the EAS system out of responsibility to the public.

Every station's EAS system is required to be periodically tested. A daily test of the presence of audio from the sources monitored (LP-1, LP-2, weather, etc.) should be made to assure that the EAS unit's receivers are properly working. The station operator should also be properly trained by station personnel regarding the monitoring of the EAS unit's Internet connection. Weekly and monthly tests will be transmitted by the LP-1 and/or LP-2 stations. These are called the required weekly test (RWT) and the required monthly test (RMT). The RMT must be retransmitted within 60 minutes of its receipt. The RMT is always sent by the originator between 8:30 a.m. and sunset during the odd-numbered months and between sunset and 8:30 a.m. during the even-numbered months. The received RWT needs to only be logged in the station log or other form of EAS log as established by the station. Other EAS messages that are rebroadcast are also required to be logged. It is the station's responsibility to assure that tests are received as scheduled. If a test is not received, the station must ascertain if the problem was with the transmission of the test by the LP-1 or LP-2 station or if the problem is with the station's EAS equipment.

Every station is required to originate a required weekly test (RWT) except during the weeks that an RMT is received. An RWT is sent by first playing the station's pre-recorded introduction of the test, then activating the send RWT function on the station's EAS encoder. This test is usually scheduled on the program log and is generated by using the station's EAS encoder, which should be programmed by the station's chief engineer for the purpose of broadcasting an RWT. The time of the transmission of the RWT should be logged either manually or automatically.

EAS rules and regulations, as determined by the FCC, tend to change from time-to-time. It is the responsibility of the station to keep abreast of current EAS requirements. Each station operator has the responsibility to learn and practice the correct EAS procedures as outlined by station management. Failure to follow a station's EAS procedures may result in the station receiving a fine from the FCC.

If the EAS equipment fails, the station operator should log the failure in the station's EAS log and should immediately report such failure to the station's chief operator and chief engineer. Some stations may select to be non-participating EAS stations. They, however, are still required to have an EAS encoder/decoder. Non-participating stations must sign off the air if an EAN is received and are not permitted to come back on the air until the EAN has been terminated with an Emergency Action Termination (EAT). Additionally, a non-participating station must still air the RMT each month.

A non-participating EAS station must have a letter of authorization providing the necessary authority for it to be a non-participating station. A station operator employed at a non-participating station should become familiar with the location of the letter and the procedures involved.

7

The Program and Station Logs and Station Identification

7.1 The Program Log

Many radio stations prepare a program log that is used as a general guideline for airing programs throughout each 24-hour period. Figure 7-1 shows a typical program log.

KZZZ-AM Program Log Friday 1/24/2015 Central Time Page 2 of 32

Scheduled Time	Length	Sponsorship | Event | Advertiser Line Remarks	Media #	Line Start / End Time
Hour: 1 AM				
01:00:00A - 04:00:00A		** RUSH LIMBAUGH REPLAY **		
01:00:00A		NEWS		
01:02:25A		LOCAL BREAK		
02:30	60	TARGET RESPONSE	C5477	12A / 12A
03:30	60	WILEY ENTERPRISES	C9363	12A / 12A
01:17:55A		LOCAL BREAK		
18:00	60	VITAL BASICS	C9268	12A / 5A
19:00	60	BUILT TO LAST FURNITU	C7929	1A / 4A
01:29:55A		LOCAL BREAK		
30:00	60	SUNFLOWER MAZDA	C9245	12A / 12A
31:00	60	TARGET RESPONSE	C7834	12A / 12A
32:00	60	CHILDREN'S MERCY HOSP	C4179	12A / 12A
01:46:55A		LOCAL BREAK		
47:00	60	ASSOCIATED AUTO GROUP	C4066	12A / 12A
48:00	60	TARGET RESPONSE	C5475	12A / 12A
01:53:55A		LOCAL BREAK		
54:00	60	TARGET RESPONSE	C5477	12A / 12A
55:00	60	STANFORD & SON'S	C2939	12A / 5A
01:57:55A		LOCAL BREAK		
58:00	60	TARGET RESPONSE	C5476	12A / 12A

Operator:	On:	Off:	Operator:	On:	Off:

Figure 7-1 A typical program log.

The program log will show when the station identification is to be made. It will show when special announcements are to be made and will make reference to the location of the script for those announcements. The program log will also indicate when newscasts are scheduled, what commercials, if any, are to be aired and at what times. The log may also make notation of what music is to be played when. Often the station may have a separate music play list or log that lists the music play schedule. The time to air other special programs such as newscasts, sportscasts or remote broadcasts will also be indicated on the program log. The program log may be created in paper form or it might be contained within a software program. The times to air public service announcements or tests of the station's Emergency Alert System (EAS) will also be noted on the program log. Every radio station maintains its program logs for two years as required by the FCC. The program logs become official documents of the station and are often utilized to resolve problems or issues that may arise from time-to-time as a result of a program that was aired over the station. Some stations may require the operator to sign on and off the log at the beginning and end of his or her shift. Corrections to the log must be made by striking out the error, initialing the strikeout, and then writing the correct entry. It is very important that the station operator follow the program log in detail and with accuracy according to station policy and instructions.

7.2 The Station Log

The station log is a method whereby the operating parameters of the station's transmitter and related equipment are recorded at a specific time for possible future reference. Figure 7-2 shows a typical station log.

RADIO STATION WXYZ
123 Anywhere Street
Hometown, USA 55555
91.7 FM – 3 kW ERP

STATION LOG

OPERATOR SIGNATURE	TIME ON	OPERATOR SIGNATURE	TIME OFF

TRANSMITTER READINGS

TIME	PLATE VOLTS	PLATE AMPS	POWER WATTS	REMARKS

TOWER LIGHTS AND EAS

TOWER LIGHT CHECK	EAS EQUIPMENT CHECK	EAS ACTIVITY
INITIAL	INITIAL	INITIAL
TIME	TIME	ACTION
LOG REVIEWED BY CHIEF OPERATOR	REMARKS	
SIGNATURE		
DATE		

Figure 7-2 A typical station log.

Operating parameters such as plate or collector voltage will be logged as well as power output and, for AM stations using a directional antenna, the operating parameters of the antenna system will likely be logged. The station log may have a place to log the daily tower light check as well as EAS tests and messages received and sent. The transmitter and antenna parameters are read via the station's remote control and monitoring system at most stations unless the studio is co-located with the transmitter site. Operating parameter readings should be taken at regular intervals as directed by the station's management.

Every station log requires the operator to sign on and off by writing the date and time that the operator began his or her shift and the date and time that the shift ended. The procedure for making corrections to the log is the same as for the program log. It is the responsibility of the station's chief operator to check the station log for correctness and accuracy and to make any corrections that may be necessary. Further information about the requirements of the station log can be found in section 73.1820 of the FCC rules.

As mentioned in section 4.30, some stations now have automatic logging whereby the transmitter computer will connect to the studio to log a set of operating parameter readings. The station operator needs to become well versed with the method of logging used at his or her station of employment.

7.3 Station Identification

The FCC assigns call letters to every radio broadcast station in the United States. Each call letter is a combination of three to seven letters typically beginning with W if the station is east of the Mississippi River and with K if the station is located west of the Mississippi River. One exception to this rule is KDKA in Pittsburgh, Pa., which received its call letter assignment in the 1920s. There are other stations that are exceptions to this as well. In addition, each station is licensed to a particular location known as its city of license.

FCC rule 73.1201 requires that every AM and FM broadcast station be identified at the beginning of each hour at a reasonable break in the programming, and also when the station signs on or signs off the air. The rule states that the station's call letters must first be given, followed by its city of license. The rule does not require the station's broadcasting frequency to be given although many stations do so as part of their on-going attempt to maintain radio dial identity with their listeners. A typical radio station identification may be as short as saying "WXYZ Pittsburgh" or it may be longer stated as saying "this is WXYZ Pittsburgh, 89.7 on your FM dial bringing you the greatest in music, news, weather, and sports." Both identifications are legal because the call letters are given first followed immediately by the city of license. Some stations will adopt a promotional name such as "the buzzard." A station identification that reads "this is the buzzard, Pittsburgh's finest rock 'n roll station" is not a legal station identification as it does not provide the station's call letters. A station identification that says "WXYZ Pittsburgh, the buzzard, Pittsburgh's finest rock 'n roll station" would be legal as the call letters and the city of license are given and placed in the correct order. The FCC also allows a station identification that would give the call letters first, then the station's frequency, then the city of license. An example would be, "this is WXYZ, 89.7, Pittsburgh." No other insertion between the call letters and the city of license is permitted. Stations that do not correctly identify themselves may be fined by the FCC.

8

Bringing It All Together

8.1 FCC Station Inspection

The FCC may inspect a station at any time. Inspections are usually conducted during normal weekday business hours. The inspector will be interested in seeing many different facets of the station's operation. A station will usually designate a specific person or persons to be responsible for hosting an FCC inspector. The station operator, if approached by an FCC inspector, should first ask for official identification and then notify the station's personnel who are responsible for hosting the inspector. The FCC inspector may ask the station operator questions about EAS, transmitter control, station identification, tower light monitoring, the station's public file, and other operating aspects of the station with which a station operator should be properly informed. A good station operator will be well versed and make all efforts to show respect to an FCC inspector. An FCC inspector has the authority to fine a station operator as well as the station's licensee if he or she finds fault with the method in which the station is being operated. Fines can range into the thousands of dollars so it is in the best interest of all concerned to operate in a professional manner at all times and in accordance with all applicable FCC rules and regulations.

8.2 Safety

The station owner/licensee is responsible for providing a safe working environment. All broadcast equipment operates using potentially lethal levels of electricity. In addition, the RF (radio frequency) signal that broadcast transmitters generate can, when touched, cause burns to the skin. Snow and ice can build up and fall off of tall towers located in cold climates. Large pieces of ice falling from a tower can cause property damage and personal injury or death. Water in the area of broadcast equipment, especially a transmitter, can cause an electrical path to ground. Station personnel should never stand in a puddle of water when touching electronic equipment. Power extension cords and the various adapters used on them can cause the safety ground on the electrical circuit to become disconnected thus causing a potentially dangerous and lethal situation. Improperly mounted speakers or other devices in a studio may fall causing bodily harm. Heat generated by some broadcast equipment can ignite flammable materials that may be stored close by.

There are a multitude of potential dangers within the broadcasting industry. The station operator should always be on the lookout for the hazards, such as those mentioned above, and take whatever steps necessary to avoid them. Any hazards observed that cannot be immediately eliminated should be quickly reported to station management for further investigation and expedient elimination. The station operator should be acquainted with the location of fire extinguishers, a first aid kit, the local emergency phone numbers, and the fastest exit route from the building. This is not a comprehensive safety review nor is it intended to be one. When in doubt, it is better to play it safe than to be sorry later.

8.3 What if the Station Goes Off the Air

If an operator suspects an off-the-air situation he or she should first determine that the proper monitor selector switch is chosen and that program audio is being produced from the audio source. Often a satellite network will stop transmitting audio due to a technical deficiency, a CD player may quit playing, or a program audio delivery computer may crash. In some cases, the channel-on switch on an audio mixing device may get turned off accidentally or, for technically deficient reasons, turn itself off. If an off-air situation is encountered, step one is to look at the audio mixing console or work surface VU meters to see if audio is being sent. Often what are thought to be off-the-air situations are simply a loss of program audio. Others are actually off-the-air situations whereby the transmitter is off-the-air.

Once the operator has assured him or herself that audio is being generated, he or she should next check the transmitter's meter readings via the transmitter's remote monitoring system or by reading the meters on the transmitter directly if it is close by. If the transmitter is found to be off the air, the station operator should try to restart it following the instructions provided by the station's engineer. If the transmitter does not restart then the operator should switch to the standby transmitter if the station has one, again following the procedures as provided by the station engineer. In cases such as this, the station engineer should be notified as soon as possible after the signal has either been restored or is temporarily lost. Most stations will have a written procedure of action required if a station goes off the air. The operator should become thoroughly acquainted with that procedure.

8.4 Bringing It All Together

This book contains a wealth of information intended to educate its reader about the aspects of being a radio station operator. Keep the book close by and use it as a reference when needed. Read and re-read it to ensure proficiency. The broadcast industry is fast-paced and requires any person who wishes to become a professional broadcaster be properly informed and otherwise kept-up-to-date with the policies, procedures, and technologies that affect each and every broadcast station and its operators. Broadcasting is not a learn-it and do-it industry. Rather, it is a learn-it-and-keep-learning-it business. A good station operator will have an educational base from which to spring forth into the world of broadcasting where he or she will gain experience by working–and will learn from others. It is our hope that you will achieve your highest goals!

Glossary

In order to properly understand the discussions within this book, it is recommended that the reader become familiar with the following terms and definitions as they are referred to frequently in the text and at radio stations throughout the country.

AF – audio frequency

AGC – automatic gain control

AM – amplitude modulation

AM array – an AM antenna system consisting of multiple towers

AMBER plan – A plan developed to work with the Emergency Alert System to inform listeners about child abductions

ampere – the unit of electrical current measurement

amplitude modulation (AM) – The method used to transmit audio on an AM station whereby the amplitude of the radio signal varies in direct proportion to the amount of audio applied to the signal

amp – abbreviation for ampere or amplifier

analog – 1)An electronic circuit using discrete electrical and mechanical components. 2)Data storage and transmission using signals of varying intensity

analog meter – a meter with a moving pointer and a numerical scale face

antenna – A metallic device used for the transmission or reception of radio signals

antenna array – a group of multiple antennas

antenna monitor – An electronic device used to monitor the operating parameters of an antenna system

antenna pattern – The collective total of all directions that an antenna radiates a radio signal

antenna tuning unit – An electronic unit used to efficiently match and transfer a transmitter's power output to an antenna input

ATU – antenna tuning unit

audition channel – One of at least two sets of audio output channels on an audio mixing device

audio – audible sound

audio frequency (AF) – frequencies of sound ranging from 20 hertz to 20 kilohertz

audio level – The intensity of audio contained within or being emitted by a device

audio mixing device – An electronic unit used to blend multiple audio sources to a common destination

audio processor – a unit used to control and or alter audio

audio router – A device used at a radio station to send audio from multiple sources to multiple destinations

automatic gain control – Any circuit or device that automatically controls the level of sound. Used to keep the output constant as the input varies

automation system – In radio, a system that automatically controls the recording or playing of audio sources

auxiliary channel – an audio mixing device output channel

auxiliary transmitter – the standby transmitter at a radio station

balanced – the term used to refer to an audio circuit where equal audio energy is carried in two wires with a surrounding shield

beacon – a flashing light on a radio tower

bit – A single unit of information storage capacity as used in computer memory

bi-directional – being capable of two directions

blast filter – The unit used on a microphone to reduce noise created by excessive air input

block diagram – A systematic chart using labeled blocks connected by straight lines to display signal flow or the relationship of multiple equipment elements

board – another name for an audio mixing device

board operator – The person who operates an audio mixing console or work surface

bottom beacon – The lower-most flashing light on a radio tower

byte – A group of eight binary bits processed together to create digital information

call director – An electronic device used to take phone calls and put them on the air

cardioid microphone – A microphone that primarily receives sound on its front side and rejects sound at its back side

carrier – a radio signal

channel assign switch – A switch on an audio mixing device used to route audio to one or more of the device's output

channel number – On an audio mixing device, the number of an audio input channel usually numbered in sequence from left to right. In FM broadcasting the designation of a frequency within the FM band of frequencies

chief engineer – The person at a radio station who is responsible for the technical operation of the station

chief operator – The person at a radio station who is responsible for the station's proper operation in compliance with all applicable FCC rules and regulations

clear channel – An AM frequency on which a high-power station is authorized to transmit and is greatly protected from receiving interference from other stations

coaxial line – A type of transmission line using a center conductor surrounded by an insulating dielectric and then covered by a metal shield

codec – an electronic device that encodes and decodes digital information

collector – the output terminal of a transistor

co-located – In broadcasting, 1) a studio that is located at a transmitter site or 2), two or more stations based at the same location

common point – A term used in AM broadcasting referring to the point of measurement of an AM transmitter's output current

composite signal – In FM broadcasting a single signal consisting of left and right audio channel information and other signal components that facilitate the transmission of a stereo signal

compression – Audio compression: a process of automatic adjustment of the variation (dynamic range) of audio volume. Data compression: the coding of digital data to reduce storage space or transmission time.

compressor – A unit used to reduce the dynamic range (variation) of audio

compressor/limiter – A unit used to reduce the dynamic range of audio and limit the output level of an audio source to a pre-determined level

condenser microphone – A microphone that depends on variations in its electrostatic capacitance for operation

conductor – Any device capable of passing electricity from one point to another

console – In broadcasting, the device used to contain audio mixing circuitry

consulting engineer – A person who specializes in certain methods and practices of engineering in the broadcast industry

control point – The location where a radio station transmitter is controlled

cue – 1) The practice of placing an audio source to the beginning of its desired start point. 2) The listening of audio for purposes of establishing a further action relative to its use while other audio is on the air. 3) Giving an announcer a verbal or physical signal to begin talking

cue channel – The channel on a broadcast audio mixing device used to listen to audio off air

cue tone – A sub-audible tone used in broadcasting to control a device

current – The movement of electrons in a conductor measured in amperes

current ratio – A term used in AM broadcasting referring to a particular operating parameter of an AM directional antenna system

DAW – digital audio workstation

dB – decibel

daytime operation – An AM station that is licensed to operate only from sunrise to sunset

day pattern – The signal radiation pattern of an AM station during its daytime operation

daytimer – An AM station that operates only during daytime hours

decibel (dB) – A unit of signal strength measurement. The unit of measurement of relative signal levels equated as the logarithmic ratio between the two signal levels

dedicated line – A telephone line used for a specific purpose such as transmitting audio for a radio broadcast

deicer – A heater element in an antenna that is used to prevent ice build up

digital – Electronic representation of information using bits and bytes

digital audio – Audio that has been converted to a digitized format

digital audio workstation (DAW) – A computer system used to record, play, edit and otherwise manipulate audio

digital meter – a numerical readout display

distortion – a degradation of sound quality

direct method – A method used to calculate or read transmitter power output directly from a meter

direct power – The power output of a transmitter as read on a wattmeter, or as calculated

directional antenna – An antenna system that radiates a radio signal of greater intensity in certain directions and less in others

directional array – A combination of antenna elements or towers used to create a directional antenna

directional pattern – The collective directions in which a directional antenna radiates a radio signal

division – The markings on an analog meter used to measure designated units of any particular circuit

doghouse – Typically a small structure located at the base of an AM broadcast tower used for housing the antenna's antenna tuning unit (ATU)

downlink – A system capable of receiving a signal from a satellite

ducking – A method used by announcers whereby the music level is reduced so the announcer can be heard over the music

dynamic microphone – A microphone that uses a moving coil within a fixed magnetic field to detect sound and produce an audio frequency current

dynamic range – The amount of variation in sound from its lowest level to its highest level at any given moment

EAN – Emergency Action Notification

EAS – Emergency Alert System

EAT – Emergency Action Termination

effective radiated power – The total power being broadcast by an FM radio station as a result of its transmitter power output, transmission line efficiency, and its antenna power gain or loss

electronic audio router – An electronic device used to direct multiple audio sources to multiple audio destinations

element – 1)The signal radiating or receiving component of an antenna system. 2)A unit inside a microphone used to detect sound

Emergency Action Notification (EAN) – A function of the Emergency Alert System (EAS) whereby the President of the United States issues a message over the EAS

Emergency Action Termination (EAT) – The term used when the Emergency Action Notification has been terminated

Emergency Alert System (EAS) – A national system used to broadcast emergency information to the general public

equalizer – a device used to alter the tone of sound

equalization – the net result of an equalizer's action

ERP – Effective Radiated Power. A term used in FM broadcasting to indicate an FM station's total radiated power

exciter – the first stage of a transmitter where its signal is originally generated

FAA – Federal Aviation Administration

FCC – Federal Communications Commission

Federal Aviation Administration (FAA) – The federal government agency responsible for air traffic control and safety within the United States

Federal Communications Commission (FCC) – The Federal Government agency responsible for all non-governmental wireless telecommunication within the United States

feedback – A tone or squealing sound that is heard when an audio source is produced and fed back to itself due to the improper placement of the source in relation to the sound producing device

feedline – a transmission line

female – A connector that can have a mating connector plugged into it

filament – The element of an electron tube that produces heat and electron flow

FM – frequency modulation

frequency – The number of times a sound wave or radio wave is repeated in one second. The unit hertz is used to define the number of repetitions (cycles) per second

Frequency Allocation Plan – A plan devised by the FCC to allocate broadcast station frequencies throughout the United States

frequency counter – An electronic test equipment unit used to measure frequency

frequency modulation (FM) – The method of modulation used by FM radio stations whereby the signal varies in frequency according to the frequency and intensity of sound placed onto the radio signal (carrier)

frequency response – A measurement of an audio source's ability to reproduce sound starting with the lowest measurable audio frequency and ending with the highest measurable audio frequency

frequency tolerance – The limits of frequency drift of a broadcast station as permitted by the FCC

gain – an increase in signal power or audio volume

gain riding – The controlling of audio level either manually or electronically

general manager – The person at a radio station who is responsible for the overall operation of the station - also may be known as the station manager

hertz (Hz) – A unit of frequency measurement. One hertz is equal to one cycle per second

hybrid – An electronic unit used to combine and divide audio signals

Hz – hertz

icing – A term used to refer to ice build-up on an antenna

impedance – An electrical term for the measurement of resistance in an alternating current (AC) circuit

increment – The division lines on an analog meter used to measure designed circuit levels

indirect method – The method of calculating transmitter power output taking the transmitter's operating efficiency into account

indirect power – Transmitter output power as calculated using the indirect method

input channel – The channel or channels on an audio mixing device that accept and control audio from various sources

input power – The amount of power placed into the final amplifier of a transmitter

input selector switch – The switch or switches on an audio mixing device that are used to select the audio source for a specific input channel

Integrated Services Digital Network (ISDN) – used in telephone systems

interpolating – The art of estimating a meter reading when the needle points in between increment marks on its scale

ISDN – abbreviation for Integrated Services Digital Network

jack – An electrical connector said to be female in style and capable of having something plugged into it

jack bay – see patch bay

jack field – another term for jack bay

kilobits per second (kbps) – One-thousand bits per second of transmitted digital information

kilohertz (kHz) – One-thousand hertz. A unit of frequency measurement such as those used in audio and AM broadcasting

kilovolt (kV) – One thousand volts. A unit of electrical voltage measurement

kilowatt (kW) – One-thousand watts. A unit of power measurement

LP-1 – The primary station responsible for the origination and relaying of messages sent over the Emergency Alert System (EAS)

LP-2 – The secondary station responsible for the origination and relaying of messages sent over the Emergency Alert System (EAS)

level – the strength or amplitude of a signal

license – an authorization issued by the FCC

Licensee – A person or company who holds an FCC license

limiter – An electronic device used to limit the output of an audio source to a specific level

live assist – A method whereby programming is handled by a computer and the announcer starts the sequenced elements and talks between the programming parts

local channel – A class of AM broadcast station designed to serve a small community and its immediate surrounding area

male – a plug or connector with a protruding body

marker lights – Tower lights located between the flashing beacon lights on a tower

megabits per second (Mbps) – One million bits per second of transmitted digital information

megahertz (MHz) – One million hertz. A unit of frequency measurement such as that used in FM broadcasting

mic – a microphone

mic processor – see microphone processor

microphone element – The internal device of a microphone that detects sound and changes it to electrical current

microphone processor – A device used to control the dynamic range and tonal quality of sound produced by a microphone

microwave – High frequency point-to-point radio transmission typically used in broadcasting to link a radio studio to its transmitter site

mid – An abbreviation for mid-range frequency when referring to audio frequencies between the low and high ranges of audio

middle beacon – the center flashing beacon on a radio tower

mike – a microphone. See also mic

miking – the setup and arrangement of microphones for recording or broadcast

mixer – An electronic unit that is used to mix or blend audio

mixing – The act of blending more than one audio source to a common output

mix-minus – An audio mix of all programming minus the caller audio

modulation – The effect of applying audio to a radio signal (carrier)

mono – a single channel of audio as not in stereo

muted – the turning off of sound

muting – the act of turning off sound

needle – the pointer device on an analog meter

network speed – The measurement of a digital network's ability to transmit a specific amount of data over a given period of time, usually measured in kilobits per second (kbps) or megabits per second (Mbps)

nighttime operation – An AM station authorized to operate at a certain transmitter power level and with a specific signal radiation pattern at night

night pattern – The resultant antenna radiation pattern being transmitted by an AM station at night

non-commercial – A station that is not permitted to air commercials

non-directional – A radio station that radiates its signal equally in all directions

non-reserved band – The band of FM frequencies ranging from 92.1 to 107.9 megahertz and used by stations that air commercials

omni-directional – Said to radiate in all directions or pick up sound from all directions equally

open mic – a microphone that is on and active

operational area – A specific geographic area as referred to in the EAS plan

output power – The amount of power output being generated by a transmitter

overdriving – A condition created by applying a signal that is too great in amplitude (level) to an input therefore resulting in distortion

patch bay – A passive device containing many jacks connected to various audio sources and destinations and used to route audio

patch panel – see patch bay

pattern – The cumulative directions that a signal radiates or that a microphone receives sound from

peak audio – The greatest amount of audio level at a given instantaneous moment

peak distortion – A degradation of sound quality caused by excessive audio levels being generated at any given instantaneous moment

phantom power – The power that is typically applied from an audio mixing console, through the microphone cable, to a condenser microphone for its proper operation

phase angle – A measurement used in AM directional antenna systems to measure physical relationships between towers or signals radiated from multiple towers

phasor cabinet – An electro-mechanic unit used to tune multiple towers in an AM directional system in order to assist in creating the required signal radiation pattern

phoner – an interview conducted over the telephone

plate – The element of an electron tube that produces power

play list – A list of programs or music that is to be played on the air in a given sequence

plug – A protruding connector referred to as male and capable of being plugged into a jack

pointer – the moving indicator on an analog meter

pop filter – A device placed over or in front of a microphone to reduce noise that would be generated by an excessive force of air being sent into the microphone element

popping – The sound that a microphone creates when too much air is forced into it such as when speaking a strong "P" consonant

Post-Sunset Authority (PSSA) – FCC authority given to an AM daytime-only station to operate for a specific period of time and at a given power level after sunset

pot – abbreviated term for potentiometer

POTS – abbreviation for plain old telephone service

potentiometer – An electro-mechanical component, either rotary in nature or sliding, that is used to control electrical energy such as in an audio mixing device to control sound levels

Pre-Sunrise Authority (PSRA) – FCC authority given to an AM daytime-only station to operate for a specific period of time and at a given power level prior to sunrise

program automation system – A computerized system used to automatically play programming at a radio station

program channel – The primary output channel of an on-air broadcast audio mixing device used to provide programming to the transmitter

program delay unit – An electronic device used to delay the time that audio arrives to the listener

program director – The person at a radio station who is responsible for organizing and overseeing the programming of a radio station

program interrupt – A device or method that interrupts the delivery of program audio being sent to the transmitter

program log – A method of listing the program material to air on a radio station and tracking its scheduled time of airing

program material – all program information broadcast by a radio station

propagation – The effects that the atmosphere has on how radio waves travel through the atmosphere

proximity effect – An increase in low frequency sound when a person speaks closely into a dynamic microphone

PSRA – Pre-Sunrise Authority

PSSA – Post-Sunset Authority

Public File – A file required by the FCC to be kept at each station and containing pertinent information about the operation of the station, its ownership, and area issues of importance

radiation pattern – The collective directions that an antenna system radiates a radio signal

radio frequency (RF) – The type of energy that a radio transmitter generates, also known as carrier

regional channel – A class of AM station designated to serve a larger city and its surrounding areas

Required Monthly Test (RMT) – A monthly test of the EAS system originated by an operational area's LP-1, LP-2, or other designated source

Required Weekly Test (RWT) – A weekly test of the EAS system originated by an individual station

remote broadcast – A broadcast that originates from a place other than at the radio studio

remote control – An electronic device that is used to control a transmitter and its associated equipment from a location other than at the transmitter

remote start – A term used in broadcasting to indicate that an audio mixing device input channel has the ability to start of piece of equipment remotely by prcssing a button

Reserved Band – The range of FM frequencies from 87.9 to 92.1 megahertz designated for use by non-commercial stations

RF – radio frequency

rotary – An electro-mechanical control that is turned clockwise or counter clockwise

router – An electronic device used to distribute multiple audio sources to multiple destinations

RMT – required monthly test

RWT – required weekly test

sales manager – The person at a radio station who is responsible for managing the sales staff and generating sales revenue for the station

sample rate – The number of times per second that digital audio is sampled for recording or playback

scale – the indications on an analog meter face plate

scrubbing – 1) The rapid back and forth movement of waveform audio in a digital audio editing device 2) The rapid passing of audio tape back and forth over a tape head

secondary tone – A sub-audible tone contained within an audio stream and typically used to trigger or otherwise control another studio device

shuttle wheel – An audio editing control used in association with audio scrubbing -- sometimes accomplished with keyboard strokes or the use of a mouse

slider – An electro-mechanical control that slides up and down or side to side in its operation such as a slide pot on an audio mixing device

standby transmitter – An auxiliary transmitter used when the main transmitter fails to operate

standing wave ratio (SWR) – The ratio of the power accepted versus the power rejected by an antenna system

station identification – The providing of call letters and the city of license of a radio station to the listener

station license – The FCC authorization to broadcast on a given frequency and at a specific power level from a specific location

stereo – two channels of audio divided into left and right channels

stereo generator – An electronic device located either at the studio or at the transmitter site and used to create an FM stereo signal

stereo pilot signal – The portion of an FM stereo signal that is used to indicate on a receiving radio that stereo is present and to otherwise facilitate the transmission of stereo audio

studio-to-transmitter link (STL) – A system utilized to transmit audio from a radio station studio to its transmitter site

sub-carrier (SCA) – A secondary signal in an FM transmission signal that contains additional information

switcher – any device that routes audio signals or other circuits from one point to another

T-1 – A high data capacity telephone line used by a radio station for the transmission of digital data from point to point

telephone hybrid – A unit used to encode and decode audio received from or sent via a telephone line

telephone interface – Any device that interconnects a telephone audio source to broadcast-related equipment

tertiary tone – A sub-audible tone contained within an audio stream and typically used to trigger or otherwise control another studio device

time delay recording – A method of recording an audio source for playback at a later time

tolerance – In broadcasting, the term used to refer to the operating parameter limits of a transmission system

top beacon – the highest flashing light on a radio tower

tower lights – the total combined light system on a radio tower

TPO – transmitter power output

transmission line – A coaxial type cable that connects a broadcast transmitter output to an antenna system input

transmitter log – A method of keeping records of a transmitter's maintenance and operating parameters

Transmitter power output – The total amount of power that a transmitter produces

transmitter site – the location of the transmitter

transmitter-to-studio link (TSL) – A system utilized to transmit information, usually data, from a transmitter site to a studio location

underwriting – Financial support provided to a non-commercial radio station

unidirectional – The pickup pattern of a microphone whereby the microphone receives sound from its front side and rejects sound approaching from its back side(also known as a cardoid pattern)

uplink – a system capable of transmitting a signal to a satellite

volt – the unit of measurement of electrical pressure or force

VU meter – A meter used in broadcasting to measure relative audio levels

watt – the unit of electrical power measurement

wave – One complete cycle of electrical, audio, or radio frequency energy first going from zero to maximum positive, back to zero, then to maximum negative, and then back to zero

wavelength – The length of one complete wave dependent upon its amplitude, velocity, frequency, and phase

windscreen – A device placed over a microphone to reduce noise caused by excessive air input

XLR – A type of audio connector used in broadcasting and having three male pins or three female receptacles

Appendix A

Radio Operator Certification Sample Test Questions

1. **To whom is a station operator primarily accountable?**
   - A. The FCC, the station's owner or its designee(s), the station's program director, and to the station's chief operator
   - B. Other station operators
   - C. Program director
   - D. General manager

2. **The FCC rules pertaining to the operation of a radio station can be found in which sections of the Code of Federal regulations?**
   - A. Parts 17, 23 and 101
   - B. The introduction and first chapter
   - C. Parts 11, 17, 73 and 74
   - D. Parts 1 through 101

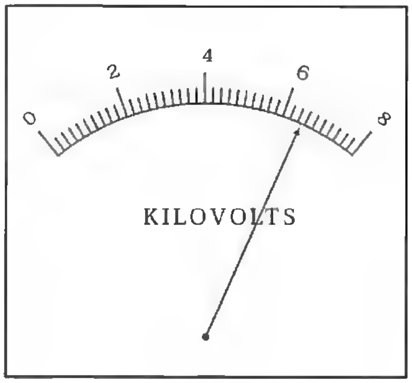
3. **What is the primary responsibility of a radio station's chief operator?**
   - A. To air the commercials and ensure a steady revenue stream
   - B. To ensure that the station is operating in accordance with all FCC rules and regulations
   - C. To be on time for his or her shift
   - D. To watch the audio levels

4. **What is the responsibility of a radio station's chief engineer?**
   - A. Install, operate, and maintain the station's broadcast equipment
   - B. Carry out his or her duties in a professional manner and in accordance with all FCC rules and regulations
   - C. Inform the station owner about new technologies that my affect the station
   - D. All the above

5. **Which unit is used to indicate a value of power?**
   - A. Hertz
   - B. Watt
   - C. Amp
   - D. Volt

6. **What federal agency limits the number of radio stations in the United States?**
   - A. The Federal Aviation Administration
   - B. The Federal Bureau of Investigation
   - C. The National Association of Broadcasters
   - D. The Federal Communications Commission

7. **What is the reading on the meter pictured below?**
   - A. 6.50 volts
   - B. 6.25 volts
   - C. 6,250 volts
   - D. 6.50 kilovolts



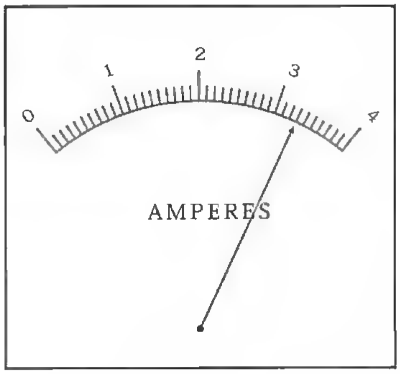
8. **What is the reading on the meter pictured below?**

A. 3.60 amps

B. 3.30 amps

C. 3.50 amps

D. 3.15 amps



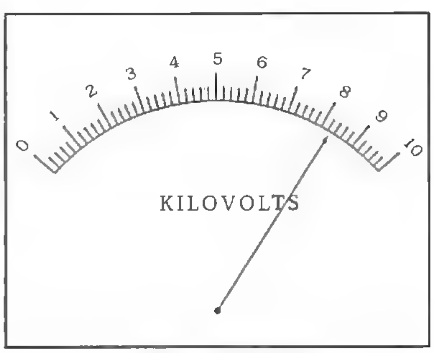
9. **What is the reading on the meter pictured below?**

A. 8.29 kV

B. 8.29 V

C. 8.14 kV

D. 8,140kV



10. **What are the primary classes of FM stations in the United States?**

A. One, two and three

B. A, B and C

C. National, international and local

D. East, central and west

11. **Daytime AM radio stations are permitted to broadcast what times of day?**

A. Sunset to sunrise

B. 8:30 a.m. and local sunset

C. Sunrise to sunset

D. Local sunrise to 8:30 p.m.

12. **FM radio stations are permitted to broadcast how many hours each day?**

A. 8

B. 12

C. 18

D. 24

13. **What are the maximum modulation limits for an AM station?**

A. 125% positive peaks and 100% negative peaks

B. 100% positive peaks and 125% negative peaks

C. 100% positive and negative peaks

D. There are no modulation limits

14. **Why are daytime AM stations not permitted to operate at night?**

A. They did not apply for a nighttime license

B. They will cause interference to other AM stations because of changes in atmospheric conditions during the night.

C. To take advantage of solar outages

D. Solar cells cannot produce electricity at night

15. **What is the purpose of using a directional antenna by either an AM or FM station?**

A. To get more listeners

B. To send secret messages

C. To prevent the signal from covering a highly populated area

D. To control a station's signal radiation pattern so that it does not cause interference to another station

16. **How many classes of AM stations are there?**
   A. Two
   B. Three
   C. Four
   D. Five

17. **What is the frequency range of the FM reserved non-commercial band?**
   A. 87.9 to 91.9MHz
   B. 87.9 to 107.9MHz
   C. 90.5 to 100.7MHz
   D. 92.9 to 107.9MHz

18. **What is the frequency range of the FM non-reserved commercial band?**
   A. 87.9 to 91.9MHz
   B. 87.9 to 107.9MHz
   C. 90.5 to 100.7MHz
   D. 92.1 to 107.9MHz

19. **What type of groups or people typically hold station licenses for the reserved non-commercial FM frequencies?**
   A. Community licensees
   B. Religious organizations
   C. Educational institutions
   D. All of the above

20. **What is the range of the AM frequency band?**
   A. 540kHz to 1260kHz
   B. 540kHz to 1700kHz
   C. 1260kHz to 1700kHz
   D. 640kHz to 1240kHz

21. **One kilohertz is equal to:**
   A. 0.1 hertz
   B. 1,000,000 hertz
   C. 1,000 hertz
   D. 1 megahertz

22. **What is the maximum permissible power for a local channel class C AM radio station?**
   A. 10kW
   B. 1kW
   C. 500W
   D. 10W

23. **What is the maximum permissible modulation for an FM station?**
   A. 100% unless additional subcarriers are being transmitted
   B. 125% positive peaks and 100% negative peaks
   C. Up to 125% if no interference is caused to other stations
   D. A maximum limit has not been set

24. **Where must the station license be kept?**
   A. Posted in a conspicuous location at the control point of the station
   B. Taped on the refrigerator in the station's lunchroom
   C. In a locked and secure file cabinet in the general manager's office
   D. The FCC no longer issues station licenses

25. **How often must a broadcast station be identified over the air?**
   A. Between every song
   B. When a long program or music sweep begins
   C. Within 60 minutes of receipt of an RMT
   D. At the beginning of each hour and at sign on and sign off

26. **What are the required elements of a station identification, and in what order must they be presented?**
   A. City of license followed by the call letters
   B. Call letters followed by the city of license
   C. Call letters followed by the station's handle followed by the city of license
   D. City of License followed by the name of the licensee followed by the call letters

27. What guides the station operator in knowing when to air specific programs?

A. The transmitter log
B. The EAS log
C. The program log
D. The Fallinova log

28. To whom should problems of a technical nature at a station normally be reported?

A. The general manager
B. The business manager
C. The owner
D. The chief engineer

29. What can cigarette smoke do to electronic equipment?

A. Damage it
B. Increase electronic flow
C. Act as a dust magnet
D. Increase electrical conductivity

30. A microphone with a single opening at its top end and openings below that opening is most likely what type of microphone?

A. Uni-directional or cardioid
B. Omni-directional
C. Multi-directional
D. Condenser

31. Which type of microphone would be a better choice for use with a loud speaking announcer who wants to speak very close to the microphone?

A. Handheld microphone
B. Dynamic microphone
C. Condenser microphone
D. Headset microphone

32. A microphone that can pick up a broad acoustic range from high to low is said to have a good ___________?

A. Frequency response
B. Windscreen
C. XLR connector
D. Mic technique

33. What is considered to be the audio frequency range of human hearing?

A. 540 kilohertz to 1700 kilohertz
B. 87.9 megahertz to 107.9 megahertz
C. 1 kilohertz to 1 megahertz
D. 20 hertz to 20 kilohertz

34. What device is used by a radio station to select and control the level of audio sources to be put on the air?

A. The patch bay
B. The audio mixing console or mixing device
C. The microphone cable
D. The transmitter

35. What are sources connected to on an audio mixing device so they can be broadcast or recorded?

A. A VU meter
B. A mix-minus bus
C. An input channel
D. A CD player

36. What is the industry term for an input channel volume control on an audio mixing device?

A. Cue bus
B. Selector switch
C. Output bus
D. Pot or potentiometer

37. What is the unit of measurement used to indicate the level of a sound?

A. The decibel (dB)
B. The watt (W)
C. The volt (V)
D. The amp (A)

38. What are the meters used to measure audio levels on an audio mixing device called?

A. Watt meters
B. Needle meters
C. VU meters
D. Kilometers

39. **Which of the following is a definition of audio distortion?**
   A. A twisting of wires
   B. A diminished clarity of sound
   C. A metal cable cover
   D. A bent take-up reel

40. **What are the numbers on a meter called?**
   A. Volts
   B. Divisions
   C. Lines
   D. Scale

41. **What is the instantaneous maximum audio level being processed at a given time called?**
   A. Peak level
   B. Sustained level
   C. Distortion and clipping
   D. Modulation

42. **What may result when an audio level exceeds the maximum reading of a VU meter?**
   A. Phase coherence
   B. Distortion
   C. An EAS test
   D. Improper impedance

43. **What does the term ducking mean?**
   A. Reducing the level of one audio source so that another audio source can simultaneously be played over it
   B. Turning an unwanted audio source off
   C. Remotely controlling a machine's functions
   D. Eliminating an objectionable comment from a listener

44. **What is the name of the switch on an audio device input channel used to send that input channel's audio to a specific output?**
   A. Input select switch
   B. Output muting switch
   C. Channel assign switch
   D. VU meter switch

45. **What is the name of the audio output channel of an audio mixing device that can be used to listen to an audio source without activating the mixing devices channel-on or channel-assign switches?**
   A. Cue channel
   B. Preview channel
   C. Program channel
   D. Elimination channel

46. **What does the term "co-location" mean?**
   A. Two different radio stations in the same office building
   B. A station's corporate office is in the same building as the radio station
   C. A studio and a transmitter located at the same place
   D. A main and auxiliary transmitter at the same transmitter site

47. **What is the name of the microwave radio system that connects the studio audio output to the transmitter's audio input when the studio and transmitter sites are not in the same location?**
   A. Studio-to-transmitter link (STL)
   B. Transmitter audio link (TAL)
   C. Microwave system approach (MSA)
   D. Stereo transmitter authorization (STA)

48. **If the studio-to-transmitter (STL) signal connection is lost, what may happen?**
   A. An EAS announcement will be sent to the station's chief engineer
   B. The station will change to a different program
   C. Nothing
   D. No programming will be broadcast

49. **What is the generic name of the device that is used with a special, digital phone line to transmit high-quality stereo audio?**
   A. POTS codec
   B. STL multiplexer
   C. ISDN codec
   D. Analog-to-digital converter

50. **What are the two most popular types of STL systems?**
   A. Microwave and VoIP
   B. Microwave and satellites
   C. Dedicated phone line and two-way radio
   D. POTS and T-1 line

51. **What is the name of the signal that contains the stereo audio and the 19kHz stereo pilot tone?**
   A. Discrete signal
   B. Combined signal
   C. Isolated signal
   D. Composite signal

52. **Which of the following devices would produce an RF signal at its output?**
   A. A microphone
   B. A transmitter
   C. A CD player
   D. An audio mixing device

53. **What does the abbreviation ERP stand for?**
   A. Electric radio pulse
   B. Effective radiated power
   C. Erroneous rheostat powder
   D. Effective reduced power

54. **Calculate the effective radiated power of an FM station with a transmitter power output of 3.5 kilowatts, a transmission line efficiency of 0.85 and an antenna gain of 4:**
   A. 0.97 kilowatts
   B. 3.5 kilowatts
   C. 8.5 kilowatts
   D. 11.90 kilowatts

55. **A radio station might use a ____________ antenna to minimize interference to another station.**
   A. Polarized
   B. Directional
   C. Non-directional
   D. Negative

56. **What should be done when a meter reading is observed to be outside the permitted tolerance and it cannot be readily corrected?**
   A. Enter the last known valid reading
   B. Skip the reading until the next time it is due
   C. Report it to the station's chief engineer or chief operator
   D. Wait until the end of your shift to see if the reading returns to normal

57. **In percent, what are the minimum and maximum permissible power limits for an FM station without a subcarrier?**
   A. 90% minimum and 105% maximum
   B. 95% minimum and 110% maximum
   C. 90% minimum and 110% maximum
   D. 99% minimum and 101% maximum

58. **What transmitter reading may increase when ice forms on the antenna?**
   A. Total power output (TPO)
   B. Effective radiated power (ERP)
   C. Standing-wave ratio (SWR)
   D. Volt-amp hours (VAH)

59. **Which unit is used to read and control a radio station's transmitter and other technical operating parameters?**
   A. Remote control and monitoring unit
   B. Program log
   C. EAS encoder/decoder
   D. Transmitter viewer

60. **What is the name given to a remote control and monitoring system that automatically monitors a transmitter's operating functions and parameters and will call a designated person in case of a problem?**
   A. Agile transmitter computer (ATC)
   B. Automatic parameter verifier (APV)
   C. Automatic transmitter system (ATS)
   D. Remote transmitter system (RTS)

61. What is the unit of measurement for power?

A. Ampere

B. Volt

C. Watt

D. Ohm

62. What method is used when a transmitter's output power is read directly from a wattmeter?

A. The direct method

B. The wattmeter method

C. Output power method

D. Ohm's method

63. If a transmitter has a plate voltage of 9 kilovolts, a plate current of 7 amperes, and an efficiency factor of 83%, calculate its power output using the indirect method.

A. 106.7 kilowatts

B. 5,229 watts or 5.229 kilowatts

C. 52,290 watts or 52.29 kilowatts

D. 1.32 kilowatts

64. What is another name for a transmitter's RF output?

A. Carrier

B. Conductance

C. Impedance

D. Juice

65. Which describes the proper procedure for turning on a tube-type transmitter?

A. Turn the plate on first, wait at least two minutes, turn the filament control on

B. Turn the filament control on, wait at least two minutes, turn the plate control on

C. Turn the filament control on, flip the plate breaker, turn the filament control on again

D. Turn the plate control on, ramp the power to the licensed value

66. What is the name of the center-most flashing light on a tower?

A. Middle beacon

B. Marker lights

C. Top beacon

D. High light

67. How often should a station without an automatic tower light monitoring device inspect its tower lights for proper operation?

A. Once every 24 hours

B. Once a week

C. Every four hours

D. Never, it's automatic

68. When a tower light outage is observed, how soon must the FAA be notified of the outage?

A. 24 hours

B. 1 hour

C. 30 minutes

D. 10 minutes

69. In a program automation system, what is the name of the mode where an announcer starts program segments and talks between them?

A. Satellite

B. Live assist

C. Fully automatic

D. Remote start

70. In an HD Radio system, the Importer enables multiple broadcasts within a single FM channel so a broadcaster can send two or more digital program channels to the exciter.

A. True

B. False

71. In an HD Radio system, the Exporter encodes main program service audio and combines it with audio and data services from the Importer.

A. True

B. False

72. **Which device interfaces a telephone line to the station's audio mixing console for the purpose of putting callers on the air?**

A. Equalizer
B. Telephone hybrid
C. Compressor
D. Microphone

73. **What kind of audio mix is provided back to a telephone caller?**

A. Mix-minus
B. Sub mix
C. House mix
D. Program audio

74. **A caller to be recorded for on-air playback must first be notified that he or she is to be recorded and must give his or her permission to do so.**

A. True
B. False

75. **What is a common name for a computer-based system that is capable of recording, playing and editing digital audio?**

A. Digital audio workstation
B. Bulk eraser
C. Audio collector
D. Tape recorder

76. **A required weekly test (RWT) is to be sent in the same week as a required monthly test (RMT) is received.**

A. True
B. False

77. **How soon must a station retransmit a required monthly test (RMT)?**

A. Within 15 quarter hours after receipt
B. Within 30 seconds after receipt
C. Within 60 minutes after receipt
D. Within 120 minutes after receipt

78. **An Emergency Action Notification (EAN) can be held until a convenient point in programming.**

A. True
B. False

79. **The allowable tolerance for an AM directional antenna system's current ratio readings is?**

A. Plus or minus 3%
B. Plus or minus 5%
C. Plus 3% or minus 5%
D. Plus or minus 10%

80. **What is used to measure AM directional antenna operating parameters?**

A. Frequency monitor
B. Antenna monitor
C. Remote Control
D. Wooden pole

81. **An FCC inspector needs to make an appointment with a station to conduct an inspection of the station.**

A. True
B. False

82. **What kind of microphone would use phantom power?**

A. Dynamic
B. Cardioid
C. Condenser
D. Omni-directional

83. **Audio compression affects the dynamic range of audio?**

A. True
B. False

84. What do the terms PSSA and PSRA mean?

A. Public service system announcement and private service relay announcement
B. Pounds per serial square area and pounds per serial rectangular area
C. Post-sunrise application and pre-sunset application
D. Post-sunset authority and pre-sunrise authority

85. If a station is suspected of being off the air, what is the proper course of action to verify the off-air condition?

A. Call the chief engineer and ask him
B. Turn the mic channel on and read an announcement
C. Check for program audio first and then check to see if the transmitter is still operating
D. Turn on as many sources as possible to ensure that something is being broadcast

86. Every radio station in the United States is required to have an EAS encoder/decoder?

A. True
B. False

Appendix B

Answer Key for Radio Operator Certification Sample Test

1.	A	32.	A	63.	C
2.	C	33.	D	64.	A
3.	B	34.	B	65.	B
4.	D	35.	C	66.	A
5.	B	36.	D	67.	A
6.	D	37.	A	68.	C
7.	D	38.	C	69.	B
8.	B	39.	B	70.	A
9.	A	40.	D	71.	A
10.	B	41.	A	72.	B
11.	C	42.	B	73.	A
12.	D	43.	A	74.	A
13.	A	44.	C	75.	A
14.	B	45.	A	76.	B
15.	D	46.	C	77.	C
16.	C	47.	A	78.	B
17.	A	48.	D	79.	B
18.	D	49.	C	80.	B
19.	D	50.	A	81.	B
20.	B	51.	D	82.	C
21.	C	52.	B	83.	A
22.	B	53.	B	84.	D
23.	A	54.	D	85.	C
24.	A	55.	B	86.	A
25.	D	56.	C		
26.	B	57.	A		
27.	C	58.	C		
28.	D	59.	A		
29.	A	60.	C		
30.	A	61.	C		
31.	B	62.	A		